REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(NEW SERIES No. 80.)

Reports to the Local Government Board:—

I.—On the use of Proprietary Foods for Infant Feeding: by Dr. F. J. H. Coutts.

II.—On the Analysis and Composition of some Proprietary Foods for Infants: by Mr. Julian L. Baker, F.I.C.

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ARTHUR NEWSHOLME,
Medical Officer,
March, 1914.

I.—On the use of Proprietary Foods for Infant Feeding: by Dr. F. J. H. Coutts.

SECTION I.

INTRODUCTION.

For many years the subject of infant feeding has received close attention from medical officers of health and others, especially in connection with the study of infant mortality and the measures required for its reduction.

At the National Conference on Infant Mortality held in 1906 a discussion took place on the subject of infants' foods and a resolution was passed calling for Government control over these materials and urging that all preparations offered or sold as food for infants should be certified by a Government Analyst as non-injurious, and that each packet should contain a statement of its analysis. Since that time representations have been made to the Board by county councils and others that action should be taken to restrict the use of unsuitable infants' foods

It was considered desirable that an inquiry should be instituted, and as a preliminary, a large number of published analyses of various proprietary infants' foods were examined and collated by my colleague, Dr. Monier-Williams. It was at once noticeable that the different methods of expression of the results of analysis made it very difficult to compare reports by different analysts on different foods, and it was also found that the information given in many of these analyses fell considerably short of what was desirable and necessary in order to form a correct judgment as to the suitability of the food for the purpose for which it was sold. A systematic and comprehensive analysis of a number of representative foods seemed therefore called for.

In order to obtain samples of representative infants' foods the assistance of medical officers of health in various parts of the

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country was obtained and they were requested to furnish samples of various infants' foods sold in their districts. To these officers and to others who were good enough to furnish samples my acknowledgments are due. Those samples are further referred to in Section III.

So large a number of infants' foods came under observation that it was deemed preferable to have an exhaustive examination made of a comparatively small but representative number rather than a less complete examination of all. It was also considered desirable to restrict this examination mainly to one particular class of foods, viz., those containing or supposed to contain starch, in an unchanged or only slightly altered form. This class seemed most urgently to require such an examination because it was not only numerically much the largest but was also the class which had been most severely condemned by sanitarians.

It was decided that the selected samples should be examined to determine as accurately as possible—

(1) the presence, nature and amount of any unaltered starch;
(2) the extent to which conversion of starch took place when the food was prepared according to instructions on the labels;
(3) the nature of the cereal from which the starch was derived;
(4) the presence or absence of diastase in active form.

Such an investigation demanded the services of a chemist specially skilled in the technique of starch analysis and the investigation was therefore entrusted to Mr. Julian Baker, F.I.C., whose previous researches on the chemistry of the starches eminently qualified him for an inquiry of the nature contemplated. Mr. Baker's report follows and is further discussed with its bearing on the general question of infants' foods in Section III of this report.

SECTION II.

Preparation and Distribution of Infants' Foods.

With the assistance of medical officers of health and others, samples were obtained of over 100 different brands of proprietary infants' foods and no doubt this number could readily have been exceeded.

Apart from preparations of cows' milk, which are frequently sold in the liquid form, practically all the proprietary infants' foods are put on the market in the form of finely-divided powders. These powdered foods are put up in glass vessels, in tins, in cardboard or paper packages, and sometimes even in common paper bags. Packages of various sizes and shapes are used for various brands and as a rule no guaranteed weight is stated. In almost every case printed matter accompanies the package either on a label attached to it or printed direct on the package, setting forth statements such as the name of the brand, the name of the proprietor or vendor, directions for preparing

the food for infants, some laudatory description of the preparation, testimonials from satisfied users and designs or pictures (a favourite design being a picture of a fat baby).

Frequently the package is contained in an outer wrapper in which is enclosed further printed matter containing testimonials, sometimes accompanied by statements as to the results of analysis, or as to the constituents of the food, and frequently by extravagant claims as to the great superiority of the particular food to others.

The proprietary foods may be divided into three groups:—

(1) The widely advertised brands made by large manufacturers and sold by pharmacists and stores all over the country.

(2) Preparations manufactured on a smaller scale by pharmacists or others and sold chiefly in one locality under the name of the person responsible for the production.

(3) Preparations manufactured on a large scale by wholesale firms and distributed to pharmacists, stores, &c., in packages marked with the name of the retailer. These are sometimes known as "own-name" brands.

The 106 samples which I received included representatives of all three classes.

Probably group No. 2 is a comparatively insignificant class at the present day. It seems represented chiefly by preparations consisting of what is practically nothing more than baked wheat flour.

Judging by the appearance and character of the food, in some instances flour, unaltered save by slight heating, had simply been put up in packets and sold at a fancy price as "————'s Infant Food"; in such cases there would be no difficulty in a small dealer putting up his own brand. But in many cases there was evidence that some attempt had been made to modify more completely the character of the flour by heating or otherwise, and it is probably more profitable for the retailer to obtain such an article ready made from a wholesale manufacturer than to prepare it himself on a small scale.

Group No. 3 probably forms a very large proportion of the total. In many cases in examining and comparing the packages it was obvious that a certain group of samples purporting to be entirely different brands were in all probability the product of one factory. The details of the wording on the labels, the arrangement of the printing, the whole style of the package and sometimes the wording of the advertising matter accompanying the packages revealed marked indications of a common origin. For example, one food for infants said to be "malted and cooked" appeared to be represented by at least seven samples, each bearing the name of a different proprietor. In each case the food was put up in tins bearing a label on which was printed the name and address of the supposed proprietor, and the name of the food was given as "————'s Food for Infants and Invalids, malted and cooked." The labels presented some slight diversity in appearance and colour, but

the wording of the various sections of the label was almost identical. Each was declared to be "the most perfect substitute for mothers' milk" except in one case in which the proprietor was satisfied with the declaration "a perfect substitute for mothers' milk." These seven samples were obtained in six different towns —London, Manchester, Salford, Birmingham, Bradford and Salisbury.

Another series of six samples contained certain portions of the wording so similar to the series of seven samples just mentioned as to suggest that both series came from the same factory. The second series, however, had certain variations in the wording of the labels, and some of the brands had reproductions of photographs of different babies on the labels. If these six are added to the previous seven, the 13 samples came from nine different towns.

Another series of six samples seemed to consist of the same food under different names and came from five different towns; and a further series of four foods bearing different proprietors' names was evidently all from one source.

In some cases the food is stated to be "prepared by" the firm whose name it bears although it is very doubtful if such is the case. In other instances the label declares the vendor to be the "sole proprietor" which suggests the idea that it is his own manufacture although avoiding the direct statement. In other cases the words "prepared for————" indicate clearly that it is not manufactured by the person whose name it bears.

The conclusion drawn from a careful examination of the packages and labels was confirmed by statements made by persons well acquainted with the trade, and from information received I was able to compile a list of over ten manufacturers who prepare infants' foods for the trade, packing them ready for sale with labels bearing the name and address of the pharmacist or dealer. Such goods are sold as if they were products having the advantage of the special skill and technical knowledge of the pharmacist whose name appears on the package. Samples of infants' foods purporting to be different brands and bearing the names of six different pharmacists in five different towns exhibit in each case on the packages, which are got up in a very similar style, three or four printed testimonials as to the value of the foods. It is rather interesting to find that two different brands, purporting to be the special productions of different pharmacists in towns 60 miles apart, each bear on the label three testimonials from mothers, and that these testimonials are absolutely identical in every detail, including the names of the mothers and the towns in which these mothers live.

It is obvious from the above that many of these retailers can have little knowledge of the article they are selling as their own proprietary infant food, often with very laudatory statements as to its value in the letter-press accompanying the packages. As a matter of fact in many cases they are probably entirely ignorant of the precise nature and composition of the article. They have absolutely no control over the quality of the materials used, or over the conditions under which it is manufactured

and considerable variations in composition may occur from time to time without their being in the least aware of them.

There can be no doubt that the sale of these preparations is in many cases a very lucrative proceeding, for as a rule these foods are relatively dear in comparison with ordinary wheat flour from which many of them differ in composition only to an insignificant extent. A 6*d.* package of No. 24 was found to contain 320 grams of the food, *i.e.* under 12 ounces. This food appears to consist mainly or entirely of baked wheat flour.

Another brand, No. 10, was packed in a tin selling at 6*d.*, the weight of the contents of the tin was found to be 230 grams—slightly over 8 ounces. This food is stated by Hutchison(1)† to consist of finely-ground wheat flour. The weight of a 4*d.* package of a third brand (No. 59) was 185 grams (6½ ounces) including the paper of the package. This is a well-known brand, declared by Hutchison to consist of baked flour. A good quality wheat flour can be purchased retail at the rate of 7 lbs. for 11*d.* or 1½*d.* per lb., so that the prices of the foods mentioned above allow of a very considerable margin to cover the cost of baking the flour and of putting the foods on the markets. The cost of 1 lb. of the food would amount to 8*d.* in the case of No. 24, nearly 1*s.* in the case of No. 10, and nearly 10*d.* in the case of No. 59 as compared with less than 2*d.* for 1 lb. of ordinary wheat flour.

SECTION III.

Nature and Composition of Infants' Foods.

Apart from special preparations of cows' milk such as humanised milk, condensed milk and dried milk, the proprietary infants' foods may be conveniently grouped in the following five broad classes:—

I. Foods with a basis of dried cows' milk but mixed with flour.*

II. Foods consisting mainly of flours,* the starch of which is practically unaltered, or altered only by heating.

III. Foods consisting mainly of flours* mixed with a proportion of malt flour or malt extract, but containing much unaltered starch which is not converted during the process of preparing the food for infants in accordance with the directions given on the package.

IV. Foods containing flours,* but also containing active diastase or pancreatic ferment, so that if the food is carefully prepared according to the directions on the package the starch is appreciably altered.

V. Foods manufactured from flours,* the starch of which has been mainly or partially converted into soluble products during the course of manufacture.

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* The word flour is used here to include not only the true cereals but other starch-containing vegetable substances, *e.g.*, flour from leguminous seeds, arrowroot, banana, &c.

† On p. 45 *et seq.* are given references to the papers referred to in the text.

Many writers have published useful analyses of infants' foods. Hutchison ([1], [2]) gives figures for a considerable number, and analyses have been given by Knight, Leeds, Cautley,([5]) König, Chittenden, McGill and in the report of the Connecticut Agricultural Experiment Station.

Valuable work in this connection has been done in the past by many chemists in their capacity as public analysts (among whom may be mentioned Mr. J. F. Liverseege for Birmingham; Dr. W. Collingwood Williams, and the late Dr. J. Campbell Brown, while acting as public analysts for Liverpool; Mr. F. W. Richardson, for Bradford and the West Riding). The results of examination of certain infants' foods have appeared from time to time in the "Lancet" and in the "British Medical Journal."

Many of these writers have called attention to the large proportion of starch present in some of these foods, and to the fact that in many cases no appreciable amount of the starch is rendered soluble after preparing the food according to the directions. For example, Cautley([2]) puts forward this point; it is also clearly pointed out by Robertson.([3])

My colleague, Dr. Monier-Williams, tabulated a large number of analyses made by different chemists of various infants' foods. On examination of these figures it was found that considerable differences existed with regard to the form in which the results of analysis were expressed. This was especially the case with regard to starch. Sometimes all carbohydrates were lumped together, or merely divided into "soluble" or "insoluble." It did not appear, therefore, that any very useful result would be obtained by endeavouring to tabulate for comparison the results of the examination of various foods by different chemists; it seemed preferable to consider rather the results obtained from the investigation carried out by Mr. Baker, whose full report follows. His analyses have been conducted with a special view to their comparability, the same methods having been used for all the various foods in the series examined, and the results stated in the same form in each case.

As will be seen, the methods adopted involved a large amount of laborious and difficult analytical work, and it was not considered practicable nor necessary to have the whole of the samples (over 100), which had been collected, submitted to this searching and painstaking examination.

In selecting the particular samples to be analysed the following points were considered:—

(1) It did not appear to be necessary to examine certain well-known preparations, as fairly full analyses of these have been published. A few of the largely advertised brands have, however, been included, mainly because they belonged to classes containing few representatives.

(2) Samples were chosen so as to give representatives of all the five classes set forth above.

(3) No samples which appeared to consist merely of dried milk or dried milk *plus* milk products were included, as a separate report on dried milks is in course of preparation.

(4) Samples were selected to include, as far as could be judged, representatives of the various cereals or other vegetable products used in the manufacture of infants' foods.

(5) Samples of certain foods were included in order to check statements on the labels or in accompanying advertisements which appeared to be of an extravagant nature and likely to mislead purchasers. It was not feasible, however, to test every brand in respect of which high-flown claims were made, and it must not, therefore, be concluded that the particular samples examined include all the unsuitable foods or that those which happened to be chosen for examination are necessarily more unsuitable than many others.

An examination of Mr. Baker's figures and tabulation of analyses shows that a very large proportion of the proprietary articles sold as infants' foods fall within classes II. and III. referred to on p. 7; 20 out of 29 (*i.e.*, 69 per cent.) consist mainly of cereal flours, the starch of which is not appreciably altered when the food is prepared according to directions.

The 29 samples examined by Mr. Baker may be arranged in the five classes as follows:—

Class.	Numbers.	Total.	Percentage of whole No.
I.	54, 68, 73	3	10·3
II.	1, 3, 4, 7, 9, 13, 17, 28, 29, 31, 51, 58, 60 ...	13	44·8
III.	14, 16, 20, 21, 26, 33, 44	7	24·1
IV.	32, 56, 63, 83	4	13·8
V.	2, 36	2	7·0

The remaining samples of infants' foods in my possession, so far as can be judged by statements on the labels or by other evidence, may be roughly grouped as follows:—

Class I., 11; Class II., 23; Class III., 35; Class IV., 3; Class V., 2; others, 3; Total, 77.

The whole 106 samples may then be classed thus:—

	Number of samples.	Percentage of total.
Class I.	14 ...	13·2
,, II.	36 ...	34·0
,, III.	42 ...	39·6
,, IV.	7 ...	6·6
,, V.	4 ...	3·8
Others	3 ...	2·8
	106 ...	100·0

These figures suggest therefore that probably over 70 per cent. of the articles sold as infants' foods belong to classes II. and III. and contain material quantities of starch which remains practically unchanged when the food is prepared according to directions.

Discussion of the Principal Constituents of the Infants' Foods examined by Mr. Baker.

Dried Milk.

Sample No. 73 contains a considerable amount, approximately half its weight, of dried milk along with cane sugar, hydrolysed starch products and only 11·7 per cent. of starch.

No. 54 is a similar preparation but containing less dried milk, more cane sugar, more hydrolysed starch products, and more unaltered starch (16·6 per cent.).

No. 68 contains roughly one-third full cream dried milk and two-thirds hydrolysed starch products with no unconverted starch.

No. 16 is called a malted milk food, but if dried milk is present it is in less amount than 5 per cent. Either lactose or possibly dried skimmed milk may have been used in its manufacture. It contains over 60 per cent. of unconverted starch.

No. 21 has also had either lactose or dried skimmed milk in small amounts added during manufacture. It contains over 65 per cent. of unconverted starch.

Cane Sugar.

All the samples contained cane sugar, but in several instances not in larger amounts than might be naturally present in the cereal products used for the food. In at least eight cases, Nos. 1, 3, 16, 32, 36, 44, 54, 73, cane sugar has been added. In these the total amounts vary from 9·2 per cent. to 16 per cent.

Fat.

In most cases the amount of fat is extremely small, not exceeding the amount naturally present in the flour used. Nos. 7 and 31, made from oatmeal, contain 8·2 per cent. and 7·8 per cent. fat respectively. Nos. 54, 68, and 73 contain fat from the dried milk used in their manufacture. No. 73 contains the highest percentage of fat in the whole series, viz., 16·6 per cent., and even this falls considerably below the percentage of fat in dried human milk (26·4 per cent.).

Fat is such an essential element in any physiologically correct infant food that it is of interest to take particular note of the proportion of this important constituent present in the samples examined.

Fat content.	Total number.	Foods numbered.
1 per cent. or under ...	9	1, 2, 3, 4, 13, 14, 32, 36, 83
1 to 2 per cent. ...	12	16, 17, 20, 21, 26, 28, 29, 33, 44, 56, 58, 60
2 to 3 per cent. ...	3	9, 51, 63
Between 6 and 9 per cent.	4	7, 31, 54, 68
Over 15 per cent. ...	1	73

That is, only one of the 29 foods contained as much as half the amount of fat present in dried human milk, and 24 out of the 29 had less than one-eighth of the amount present in dried human milk.

Starch.

All except Nos. 2 and 68 contain appreciable quantities of unaltered starch, the lowest amounts being 11·7 per cent. in No. 73, 16·6 per cent. in No. 54, and 20 per cent. in No. 36. The majority (22) contain over 60 per cent., the highest amounts found being 74·6 per cent. in No. 4 and 75·2 per cent. in No. 13. The nature of the starch indicated that the principal flour used in most cases was that derived from wheat. Nos. 7 and 31 were made from oats, Nos. 9 and 51 contained both wheat and oat flour. No. 63 contained wheat and banana flour, No. 14, arrowroot and a cereal, No. 58 lentil flour, and No. 13 colocasia starch (a product obtained from the tubers of plants of the *Arum* family).

Hydrolysed starch products.—No. 2 consists principally of such products (79·7 per cent.); No. 36 contains 45·3 per cent., and is a malted wheat flour containing still 20 per cent. of practically unaltered starch and having 9·2 per cent. of added cane sugar. No. 68 is a completely hydrolysed starch (53·4 per cent.) with a certain amount of full cream dried milk. No. 73 contains 10 per cent. of hydrolysed starch, some unchanged starch, and a considerable proportion of dried milk.

Proteins.

These vary between 1·8 per cent. (No. 13) and 24·2 per cent. (No. 58), whilst dried human milk contains 12·2 per cent., but it is to be remembered that in the great majority of cases the proteins are mainly or entirely vegetable proteins, and therefore in all probability, as pointed out by Hutchison,(1) differ markedly from milk proteins in their capacity for easy digestion by the infant.

Mineral matter.

This varies from 0·5 per cent. (Nos. 4 and 29) to 3·8 per cent. (No. 73), 4 per cent. (No. 54) and 4·1 per cent. (No. 68). The samples in which the mineral matter was high were all compounded partly of dried milk. A large number of samples contain less than 1 per cent. of mineral matter as against 2·1 per cent. in dried human milk, notwithstanding which, in regard to some of them, special stress is laid in the printed matter appearing on the label as to the bone-forming powers of the food.

Composition when prepared as directed.

It is obvious from a casual examination of the table of analytical results given by Mr. Baker that the chemical composition of these 29 foods bears no very close approximation to

that of dried human milk. But as many of these foods are directed to be prepared with milk it seemed desirable to calculate the composition of the mixture of patent food and milk when prepared according to the directions on the package with cows' milk of average quality. For this purpose an average cows' milk was taken to consist of protein, 3·5 per cent.; fat, 3·8 per cent.; sugar, 4·5 per cent.; and ash, 0·7 per cent. = 12·5 per cent. total solids.

By experimental weighings of nine of the foods it was found that one teaspoonful corresponded to from 4 to 4·9 grams of various foods; one dessert spoonful was found to equal 9·3 to 9·8 grams; and one table spoonful 17·7 to 20 grams; a basis was thus obtained for calculating the weight of food used according to the directions on the label.

It was thought best to calculate the composition of the mixture on the total weight of solids in the amount of milk and of patent food used. This makes it easier to compare the composition of the mixture with that of the patent food itself as given by Mr. Baker, and with the composition of dried human milk or dried cows' milk. In these calculations the weight of the food was taken as if it were absolutely dry, the percentage of water present in each being ignored. The milk solids of the cows' milk, however, were calculated on the basis of 12·5 per cent. of dry material.

As an example of the method adopted, food No. 1 may be taken. This food is directed to be made with one teaspoonful of the food and ½ pint of boiling milk and water, equal parts. One teaspoonful was taken as equal to 4·5 grams weight. Half-a-pint of milk and water in equal parts is equal to ¼ pint of milk, or, allowing for the specific gravity of milk as 1,030, equal to 146 grams of liquid milk. This weight of milk on a basis of 12·5 per cent. of total solids would contain 18·25 grams of dry substance. The total amount of dry material in the mixture then of food No. 1 and milk was 18·25 grams (milk derived) + 4·5 grams (food derived), or a total of 22·75 grams. The proportion of the various constituents are set out in the following table:—

	Milk derived in grams.	Food derived in grams.	Total in grams.	Percentage.
Protein	5·11	·4	5·51	24·22
Fats	5·55	·04	5·59	24·59
Lactose	6·57	—	6·57	28·88
Cane Sugar ...	—	·43	·43	1·87
Starch	—	2·97	2·97	13·05
Ash	1·02	·03	1·05	4·60
Water, &c.	—	·63	0·63	—
Total solids ...	18·25	4·5	22·75	—

The following table gives the result of these calculations as applied to the various samples when mixed as directed, figures for human milk and for cows' milk being added for comparison:—

—	Protein.	Fat.	Milk Sugar.	Cane Sugar.	Other sugars or hydrolysed starch products.	Starch.	Ash.
	%	%	%	%	%	%	%
Dried Human Milk(*a*)	12·2	26·4	52·4	—	—	—	2·1
Dried Cow's Milk(*b*)	23·8	28·7	39·0	—	—	—	5·8
Do. calculated(*c*)	28·0	30·4	36·0	—	—	—	5·6
Patent Food in mixture of Food and Cow's Milk in proportions directed:—							
No. 1	24·2	24·6	28·9	1·9	—	13·1	4·6
„ 3	21·5	16·1	19·0	6·1	1·6	25·5	3·7
„ 9	24·7	24·8	30·0	·26	·18	11·5	4·8
„ 13	25·5	27·0	31·8	·24	—	8·3	6·0
„ 14	24·1	24·1	28·0	·28	—	15·2	4·5
„ 16(*a*) ...	26·4	26·8	31·7	1·2	·17	7·4	5·1
„ 16(*b*)* ...	10·7	1·6	1·8	9·9	1·4	60·2	1·3
„ 17	21·5	20·1	23·3	·39	·1	25·4	3·8
„ 20	22·4	20·1	23·3	1·73	·46	24·7	3·9
„ 21	20·0	15·3	19·4	·52	1·74	34·2	3·2
„ 26	22·8	20·3	23·3	1·53	·43	24·7	3·8
„ 28	16·1	14·8	17·2	26·6	—	19·4	3·0
„ 29	25·1	25·1	30·0	·25	·17	10·7	4·8
„ 31	24·8	25·7	28·3	·13	·13	13·7	4·5
„ 32†	12·6	5·5	5·5	9·0	2·18	55·2	1·5
„ 33	22·2	20·0	23·3	·53	·28	25·2	3·8
„ 36†	11·8	5·1	5·6	7·72	38·2	16·8	2·5
„ 44	19·8	17·3	19·8	4·42	·68	28·3	3·3
„ 51(*a*) ...	21·5	17·8	19·7	·75	·27	32·1	3·4
„ 51(*b*)* ...	13·0	2·0	—	1·7	·6	71·1	·7
„ 54	24·0	21·9	26·6	5·41	7·05	5·5	5·3
„ 56	21·6	17·8	20·0	·9	23·02	9·3	3·5
„ 58*	24·2	1·2	—	4·2	·7	53·4	2·1
„ 60*	8·9	1·3	—	1·7	·5	73·3	·7
„ 63	21·7	19·6	22·3	1·62	1·71	22·1	4·0
„ 68*	14·0	8·5	10·0	3·7	53·4	—	4·1
„ 73*	15·0	16·6	20·0	11·7	10·0	11·7	3·8
„ 83	17·8	12·2	13·6	·74	32·6	13·63	2·8

(*a*) Hutchison. (*b*) Baker. (*c*) Dried milk of composition on p. 12.

* Directions state that the food may be prepared with water only, and the figures given represent the proportions of the various constituents when the food is thus prepared.

† Directions mention one tablespoonful of milk *or more*. This is calculated on one tablespoonful.

In several instances the directions are vague and allow considerable latitude as regards the proportion of water to milk, *e.g.*, Nos. 14, 20, 26, and 31. In such cases the above calculations are based on *equal* proportions of milk and water, but in practice the mother in straitened circumstances would probably reduce the proportion of milk.

Nos. 16 and 51 are directed to be made with boiling milk or water; the calculations show the percentages (*a*) when an equal amount of milk and water is used and (*b*) when water only is used. Of course, if boiling milk alone without water were used, the proportion of the constituents given for No. 16 (*a*) and 51 (*a*) would be altered. Nos. 16, 32, 36, 51, 58, 60, and 68 when made with water or only a very small proportion of milk are entirely unsuitable for infants' food, the proteins being the only food element present in anything approaching the proportion in human milk.

Taking the table as a whole it will be observed that in these mixtures the protein is usually in considerable excess as compared with human milk, and approximates to the proportion in cows' milk. The fat is very deficient in some cases and rather low in many others. In the case of Nos. 3, 28, 32, 36, 44, 56, 73, and 83 (and in 51 even when made with milk), the amount of carbohydrate is proportionately much too great for the amount of fat, and it is generally considered that such a disproportion is one of the causes of rickets.

Even when made with the full quantity of cows' milk some of these mixtures contain unchanged starch in very excessive proportions. Probably anything above 10 per cent. of starch in the solids of the mixture of proprietary food and milk is decidedly excessive and unsuitable for an infant. Nos. 1, 3, 9, 14, 17, 20, 21, 26, 28, 31, 32, 33, 36, 44, 51, 58, 60, 63, 73, and 83, and 16 if made with water, all exceed this proportion of starch, and in some of them the proportion is largely exceeded.

It is true that some samples of barley water, when mixed with an equal quantity of milk, may contain as much as 10 per cent. of the total solids in the form of starch.

Thus in an analysis published recently, in a sample of barley water the total solids amounted to 2·91 per cent., the starch being 1·98 per cent. A mixture of 100 grams of an average milk containing 12·5 grams total solids, with 100 grams of such a barley water containing 2·91 grams of total solids would contain 15·41 grams of total solids, of which 1·98 grams was starch. The starch therefore would represent 12·85 per cent. of the total solids.

As is mentioned on p. 30, however, several eminent authorities believe that barley water may be distinctly harmful and others consider that the proportion of starch in barley water should not exceed 1 per cent.

In the early days of food chemistry the gross chemical composition of food elements was apparently considered sufficient evidence of the suitability of the food. All proteins were looked upon as the same in constitution; one sugar was supposed to be able to replace perfectly any other, and moreover all carbohydrates were considered to be equally assimilable. Starch might therefore, according to this view, quite well replace sugar, and there was a strong tendency to regard carbohydrates as being capable also of replacing fats.

Under this view, if an artificial food could be manufactured containing a similar amount of protein to that in the solids of milk, and with carbohydrates equivalent to the sum of the sugar and fat in milk it was thought that so far as nutrition was concerned the substitute food could replace the natural food even if the greater part of the carbohydrates were in the form of starch. As pointed out below, nutrition is not such a simple chemical problem, but the persistence of these old views probably explains such statements as the following, which appears on the labels of several presumably different brands of infants' foods:—"It contains all the nutritive elements of human milk—carbohydric, albuminous, and saline—in approximately the same proportion in which they exist in this secretion, *and is therefore capable of supplying an equivalent of natural nourishment.*" Or the following:—"For infants brought up by hand the food given should provide all the nutritive constituents of human milk; that is, that it should contain carbonaceous, nitrogenous, and phosphatic materials in approximately the same proportions in which they exist in the natural secretions."

One of the brands which publishes this statement also contains a quotation purporting to be from Liebig on malted food to the effect that "It promotes the health of the robust and imparts vigour to the delicate. Infants fed on this food are neither fretful nor wakeful."

Liebig's authority is invoked on several other labels, especially those of foods claimed to be malted—"prepared on strictly scientific principles as laid down by the late famous *Professor Liebig*"; and it would appear that many of the firms manufacturing infants' foods at the present day base their views as to the suitability of the diet on the chemical pronouncements of Liebig.

Changes in Composition without Notice to Purchaser.

A point of some importance in connection with these proprietary infants' foods is that, as no standard is laid down and no declaration of composition is required, the manufacturer can vary his method of manufacture from time to time, or make changes in the ingredients used which may lead to considerable variations in the chemical constitution of the particular food, without giving any public notice of the change, and the food may continue to be sold under the same brand.

That such variations do occur there is little doubt: McGill has referred to the possibility of such alterations. Pritchard(5) points out that one of the objections to these so-called patent foods—apart from those based on physiological and economic grounds—is the fact that there is no guarantee, except the good faith of the manufacturer, that the food is of uniform standard.

The following are examples indicating such changes of composition:—(1) An analysis of a certain food was published by the "Lancet" showing 11·8 per cent. of fat. An analysis of another sample published by the same journal some time later showed

23·4 per cent. of fat and less carbohydrate, and the inference is that the publication of the first analysis had led to a change in the manufacture. (2) A well known food was found to contain 1·3 per cent. of fat. Other samples examined by the same analyst at a later date contained an average of 8·8 per cent. of fat. (3) Another infants' food showed an increase in fat from 5 per cent. to 8 per cent. between two analyses made for the "Lancet."

Analyses by different analysts of the same food show considerable variations, thus:—(4) Food A, reported by one analyst to contain 0·27 per cent. of fat was found by another analyst to contain 3 per cent. of fat. (5) Food B, fat given by one analyst as 1·6 per cent. and by another as 7·9 per cent. (6) Food C, variations in fat from 10·8 per cent. to 15 per cent. (7) Food D, variations in protein from 7·7 per cent. to 12·8 per cent. (8) Food E, variations in proteins from 10·5 per cent. to 13·2 per cent.

It is true that improvements in the technique of analysis with regard to the extraction of fat in analysing dried preparations may account for some of the differences between early and later analyses by different chemists, but they would scarcely account for examples 1 to 3, where the same analyst examined at a short interval two samples of the same brands. There can be little doubt, therefore, that variations in composition do occur either owing to changes purposely made or owing to want of care in the manufacture.

SECTION IV.

Discussion on the Suitability of Proprietary Foods Containing Starch for Infant Feeding.

Physiological Considerations.

Nutrition is not merely a chemical problem; physiological adaptation is a much more important factor. Substances may have the same general chemical composition but possess entirely different nutritive properties. Chapin(1) says cellulose (paper) ($C_6H_{10}O_5$) should on merely chemical grounds be as good a food as starch ($C_6H_{10}O_5$). Cane-sugar ($C_{12}H_{22}O_{11}$) should always be interchangeable with milk-sugar ($C_{12}H_{22}O_{11}$), and all caseins should act alike. The mere supplying of a due proportion of protein, carbohydrate, fat, and mineral matter does not solve the problem of a suitable diet. As Chapin(2) points out it would be impossible to feed a dog on cut hay, or a cow on bones and meat, even if chemical investigation showed that there was enough of the necessary food constituents for the requirements of the animal.

Milk is the only physiologically suitable food for young mammals. Even as regards milk, modern physiological chemistry has shown that there are considerable differences between the milks yielded by different species of animals. These differences exist not only with regard to the percentage of the various food elements present but also with regard to their condition. The proteins especially have been found to be different for each species, and it has been stated that there is also a difference between the fats of bovine and human milk.

As Pisek points out, many young animals at birth are still in an embryonic condition, dependent on the mother. The digestive organs are not ready to assume their permanent functions immediately after birth but undergo a process of growth and development. According to Chapin([2, 3]) the proteins of various milks differ because the milks have a developmental as well as a nutritive function, being intended to prepare young animals for the food of adult life, and the milks of different species are not interchangeable. He also says([3]) that the milk of animals whose digestion takes place chiefly in the stomach forms solid curds (milk of cow, goat, sheep), whilst the milk of animals whose digestion is principally intestinal forms soft gelatinous curds which easily pass into the intestine (milk of mare and ass). The human digestive tract stands between these two types. Hutchison([1]), Cole, Knight and other writers have also drawn attention to the differences between the milk of different species.

These considerations lead to the conclusion that the only physiologically correct food for a young mammal is its mother's milk or the milk of some other animal of the same species. Clinical experience, and especially the records of the enormous mortality during the first year of life in infants fed artificially as compared with those breast fed, emphasise this opinion. The great majority of those medical practitioners* who have specially studied the question of infant feeding have emphasised this point, and it is generally agreed that the attempt to find the perfect substitute for mother's milk is doomed to failure and that it is therefore of the utmost importance to endeavour as far as possible to provide the baby, especially in the first few days and weeks of life, with mother's milk.

On the other hand, it is certain that there is a great power of adaptability in the digestive system of a healthy infant, and that provided care and patience are exercised a child may be gradually trained to take some other food (Lamb, Pritchard([2])).

All physicians agree that, on the whole, cow's milk forms the most generally applicable basis for the substitute feeding of infants (*see* Fordyce, Cautley([3]), Chittenden, Southworth, &c.). Many are inclined to the opinion that it is best given without the addition of any foreign material except perhaps water. Wood and others claim that infants can readily be trained to take fresh undiluted cow's milk. Budin and Variot report great success with sterilised cow's milk and Dr. Janet Lane-Claypon's report to the Local Government Board shows that recently boiled fresh milk has been used with good results in Berlin.

Mastin points out that digestion in infants is almost wholly intestinal, the stomach acting to a great extent merely as a reservoir. The proteins of breast milk being the normal human proteins are to a considerable extent, in the early days of life at least, absorbed unchanged and require no digestion. The proteins of cow's milk are less readily assimilated whilst vegetable proteins impose still more work on the digestive organs (Jung).

* *e.g.*, Hutchison([1]), Holt, Corlette, Burnet([1]), Southworth, Byrne, Goodhart and Still, and Chapin([3]).

Human milk lays no strain on the infant's digestion. As the infant develops, its powers of digestion also develop, gradually preparing it for the diet of adult life, but it does not necessarily follow that as soon as the digestive ferments required for a given type of food are present in the infant organism that such a type of food is at once suitable for the infant.

Formation of Amylolytic Enzymes.—With regard to starch, Schiffer showed that when newly born infants were given starch paste in bags to suck, sugar conversion took place showing activity of the saliva and the presence of ptyalin even at that early age.

Korowin in 1873 pointed out that the secretion of the pancreas of children in the first month of life has absolutely no sugar-forming action on starch. By the second month the enzymic action of the pancreas makes its appearance, but it is still insignificant. It is stronger by the end of the third month and gradually increasing, is in full force by the end of the first year. On the other hand, his experiments showed that even on the first day of life the juice of the parotid gland had already the power to convert starch.

Zweifel in 1874 corroborated these observations of Korowin's as regards the secretion of the parotid gland, but pointed out that the extract of the submaxillary gland gave only negative results. He also confirmed Korowin's statements as to the lack of starch-transforming power in the pancreatic secretion before the end of the first month of life, but he added that even in the first month of life the pancreatic juice has the power of converting protein bodies (casein and fibrin) into peptone and to decompose neutral fats.

Other observers have obtained similar results except that some have found the juice of the submaxillary glands also active in early infancy and some have even declared that the pancreatic secretion is sometimes actively amylolytic even in the first month of life. (*See also* Ibrahim.)

Keating gave boiled maize starch paste in linen bags to babies to suck for two minutes at a time. He observed 21 children of ages ranging from 6 days to 17 months. Sugar conversion was observed in all but 3, a marked result occurring in one baby only 7 days old.

Friedlander, 1908, made experiments on the digestibility of various foods in infants. He used potatoes boiled for 2, 5, or 10 minutes. In one case of an infant 5 months old there was partial digestion of the potato boiled for 10 minutes. In 4 cases ranging from 11 months to 13 months old there was also partial digestion. In 16 cases ranging from 10 weeks to 13 months of age there was no digestion.

Kerley, Campbell and Mason made a study of the stools of starch-fed infants. They used raw barley flour for the preparation of the barley water used in order to make the test a severe one, but this was cooked for 1½ hours. In some cases the barley water was used as a milk diluent, in others it formed the only nutriment. In 33 out of 60 children the test for starch in the stools was persistently negative. Of these 22 were 6 months old or over; only 11 were under 6 months. In 7 cases

the test for starch was persistently positive; in others sometimes positive sometimes negative. Of the 27 children passing undigested starch at times 19 were under 4 months old, 5 between 4 and 6 months, and 3 between 9 and 12 months.

Lopez examined the stools of 25 starch-fed infants, all between 2 and 6 months of age. Fifteen of these had normal digestion at the beginning of the experiment, 10 had suffered from intestinal indigestion. Free starch was found in the fæces, but Lopez concluded that much was digested, and states further that infants who had previously suffered from intestinal disorders improved on this diet.

Benedict criticised the work of Lopez and suggested the probability of the destruction of starch by bacteria. He also said that the investigations had apparently been carried out on starving babies who might be expected to extract every particle of nutriment from the diet.

The work of Pawlow has thrown much light on the development of the digestive functions. He showed that the work of the digestive glands is elastic to a high degree. When the food is altered the enzyme of the pancreas becomes day by day more adapted for the new food. Feeding on starchy food causes an increase in the starch-splitting enzymes; feeding on flesh food increases the proteolytic enzyme. He also pointed out that an abrupt transition from one regime to another may produce serious illness, but by gradual change of diet the pancreas can be gradually trained to supply the necessary enzyme. Bainbridge stated that no lactase was present in the pancreas of adult dogs, but after feeding such dogs for two or three weeks on a milk diet, their pancreatic juice invariably contains lactase. He considered the formation of lactase to be a specific reaction to lactose and a definite adaptation on the part of the pancreas to a milk diet. Plimmer, however, concluded that under no circumstances is there any adaptation of the activity of the pancreas to the presence of lactose in the food.

The work of Hamburger and Hekma showed that enterokinase in the intestinal juice stimulated the activity of some of the pancreatic enzymes but did not augment the starch-splitting power, and that intestinal juice itself had only a very feeble action on starch.

Martin and Williams showed that bile acts as an auxiliary in promoting the amylolytic action of pancreatic juice, and other recent work has suggested the presence in the body of certain activating enzymes which may stimulate the production of starch-splitting ferment.

The work of these observers naturally suggested the question whether starch can be looked on as entirely unsuitable and harmful in the diet of infants. Although starch is not present in human milk the infant has in its saliva some capacity to digest starch and after the end of the first month of life its pancreatic secretion has some power to deal with starch. Pawlow's researches suggest that the giving of starchy foods may lead to a gradual increase in the enzymes capable of splitting starch and rendering it suitable for digestion.

The secretion of the salivary glands at birth is, however, extremely small and for the first six to eight months the quantities are so minute as to be of little practical value.*

Taking into consideration the small secretion of saliva in the infant and the fact that the liquid nature of the food does not tend to stimulate the secretion of saliva and an increased production of ptyalin, it may, I think, safely be concluded, notwithstanding the digestion experiments mentioned above, that for practical purposes salivary digestion of starch in the ordinary infant is a negligible matter.

But the observations which show the possibility of pancreatic action and the possibility of training the pancreas to increased secretion of amylolytic enzyme cannot be summarily set aside.

It may, however, reasonably be urged that the mere presence in small amount in the infant organism of internal secretions able to digest starch is not sufficient proof that starch is a suitable food for babies.

On the same line of argument one might hold that the presence of gastric juice and hydrochloric acid in the infant's stomach justified the feeding of a baby on minced beef.

The presence of such secretions at an early stage may merely indicate that the organism is preparing and adapting itself for functions ultimately to be exercised. The hurrying on of nature by stimulating the formation of starch-splitting enzymes in excess of the amount normal for the age of the infant may conceivably be distinctly prejudicial.

There is some evidence to warrant the belief that the right way to begin the use of starchy foods even at a later age is by giving hard foods requiring mastication, thus training the child in the use of the teeth and the jaws, stimulating the flow of saliva, and setting the digestive process working in the orderly and systematic manner intended by nature.

The opposite method of commencing the employment of starch by giving it in the form of soft, pappy foods washed down with milk or water is considered by Sim Wallace, Wheatley and Campbell to be responsible for defective teeth, adenoids and other troubles in young children.

Use by Physicians of Starchy Foods.—It is not surprising that the physiological and chemical observations above-mentioned have led some physicians to recommend starchy foods somewhat freely in the dietary of hand-fed infants. This movement has been more marked in the United States and in Germany than in England. As a rule, however, the advocacy of starch is tempered with a recognition of the ill effects which may follow unless the quantity is kept within low limits. It is also recognised that raw or unchanged starch should not be given and that the quantity of starch should be very small in the early months; the proprietary foods containing unchanged starch are universally condemned. The form of starch preparation usually recommended is that of cereal decoctions.

* Fordyce, Kahler, and others.

Most of the writers* urge prolonged boiling of the cereal so that the starch granules are completely swollen up and their cellulose capsules ruptured and the starch gelatinised, as in this condition it is capable of being acted upon by the saliva, whilst in the raw state ptyalin attacks starch only very slowly. The gelatinising of the starch probably aids also the action of the pancreatic juice. Holt says that insufficient cooking is responsible for much of the starch indigestion seen in young people. He says that gruels made from barley, oatmeal, rice, arrowroot, or wheat flours should be cooked for at least 20 minutes. When made from the grains four to six hours' cooking is required.

Jacobi([1,2]) has persistently advised the use of these cereal gruels for many years. Dennett and Chapin([4]) also recommend them.

Teimer suggests *weak* cereal decoctions after the beginning of the fourth month of life; Rietschel recommends beginning in the second month with a gruel containing 1 to 3 per cent. of starch, giving starch more copiously from the sixth month onwards.

Chapin([4, 6]) says that freshly made cereal decoctions can be used as diluents to attenuate the casein clot of cow's milk, but the best effect is obtained when the starch "is completely gotten into soluble forms so that the proteids and cellulose of the cereals are free."

Finkelstein (quoted by Lamb) says the addition of starch to milk is not only permissible but to be most highly recommended, causing a finer coagulum, relieving constipation, and because of its protein-sparing power and greater resulting growth. Holt believes cereal gruels unnecessary and on the whole undesirable for healthy infants with normal digestion, but that they may be of service for infants with disturbed digestion, especially for those whose trouble is particularly with the proteins.

Availability of Starch for Infants.—Important papers by Corlette and Cautley([1]) put forward fully the arguments from physiological research as to the availability of starch for infants. Corlette, whilst indicating that physiological research suggests that infants can be trained to digest starch, says that whether young infants ought or ought not to be given starch in some or any form is a different question, not physiological but clinical, and the answer must depend on the result of clinical experience.

Cautley, whilst stating that a large number of physicians (Finkelstein and others) advocate the use of starch for purposes of nutrition in very young infants, adopts a somewhat cautious attitude. He says that the work of the observers already referred to affords physiological and chemical support of the empirical use of starch in infant feeding. There is no inherent reason, he says, why the training of the pancreas by means of a starchy diet to secrete increased amounts of amylolytic enzyme should not be begun shortly after birth, instead of waiting until the child has attained the age of six months.

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* *See* Dennett, Kerley, Campbell and Mason.

He advises, however, that in such a case a milk mixture containing not more than 0·5 per cent. of starch should be used at first, the amount being gradually increased up to as much as 3 to 5 per cent.

Many writers, whilst conversant with the physiological work alluded to above, nevertheless come to the conclusion that it is not desirable to give starchy foods to infants under the age of six months for purposes of nutrition, although some of them approve of the use of weak cereal decoctions as diluents of cow's milk for the purpose of reducing the tendency to form curds and, according to Graham, to assist in the digestion of protein. (Hutchison(1), however, says that the presence of much starch in the intestine is unfavourable to the absorption of protein.) In many instances it is contemplated that the amount of starch in the diet should be kept below 1 per cent. (Overend, Graham), whilst Rotch and Morse say 1·3 per cent. is the maximum permissible.

The fact that starch is not a natural constituent of milk appears to many* to be a sound reason for deferring the addition of starch to the infants' diet to an age when the normal development of the digestive organs has reached the stage at which sufficient power of dealing with starch has been naturally acquired. Rotch says: "It is irrational to add an element such as starch, which never exists in milk, except as a foreign element, and has been proved by nature to be absolutely unnecessary for nutrition in the first year of life."

Hutchison(1) says: "One may admit that recent observations have shown that even quite young infants are able to digest much more starch than was formerly believed. The practical fact, however, remains, that starch forms no part of the diet of a naturally fed infant until, at least, after the cutting of some of its teeth; and further, experience shows that the presence of unaltered starch in the diet of young infants is prone to excite disorders of the stomach and bowels."

Pritchard(1) says that starch given at an early period of life is digested, but in the wrong way, in the wrong place, and by the wrong agencies, being broken down in the intestine by bacteria and causing irritation.

It may be admitted however that there is some evidence to show that certain infants have an exceptional capacity to digest starch at an early age, and that this condition is especially apt to be found in babies who cannot digest cow's milk well. This point was mentioned to me by a general practitioner who had made a careful study of the feeding of individual cases. Whilst condemning the general use of starchy foods he stated that there were some rare cases of "starch" babies, as he called them, who did not thrive well on ordinary diet but could take starchy foods exceptionally well. Fordyce points out that whilst starchy food is as a rule very largely non-assimilable in infant life "there are probably wide variations in the capability for starch conversion and for starch absorption." Hutchison(1) also refers to the fact that unusual capacity to digest starch sometimes accompanies inability to digest milk. But the fact that idiosyncrasies of this

* *e.g.* Graham, Rotch, Cheadle (1).

kind exist does not justify the routine use of starchy foods for any or all babies. It rather suggests that such foods should never be given to babies except under the express directions of a medical man.

The view taken by such writers as Cheadle(1), Holt, Robertson(1, 2), Wells, Divine, and others is that the stimulation of the pancreas to an increased secretion of amylolytic enzyme by the use of starch in the diet may well be deferred until the sixth month, and even then the starch should be added in extremely small amounts at first.

Cautley(2) himself says it is often advisable not to commence the use of starch before the age of six months "except in very small amounts(4). Cameron thinks starchy foods may be useful for children over 7 months. Graham suggests that they can be given with advantage *after* the eighth month. Fordyce, Cole, and Miller would delay the giving of starchy food until the start of dentition; Sutherland(1), Burnet(1), Still(1), and Oliver, until the ninth month; Goodhart and Still and Robertson(2) would wait until the end of the first year of life, at least as far as regards the use of unchanged starch, and Hutchison(1), Holt, and Burnet(3) advise giving starch in a partially converted form only, and mixed with milk between the 6th and 12th months.

Many physicians, however, especially in America, are prepared to allow, at an earlier period of infancy than the sixth month, the use as an addition to cow's milk of starchy foods in which the starch has been mainly converted into dextrins or sugars either by prolonged heating or by the action of diastase. Chapin(4, 5) takes this view, as do also Pisek, Cole, Cheadle(1), Terrien, and Edsall and Miller, who recommend predigested legume flour. According to Holt, Keller uses a large proportion of starch along with malt for his "malt suppe."

As Corlette stated, the question of giving starch to infants must ultimately be decided not on physiological grounds but on the results of clinical experience. From this point of view, whatever uncertainty there may be on physiological grounds as to the capacity of infants to digest starch, clinical evidence gives us positive proof that starch is, as a rule, harmful. Parker, it is true, in 1887, declared to the Society of Medicine of London his belief that the danger of starch foods had been very greatly exaggerated. He appeared to believe that infants cannot digest starch but he doubted if the starch were actively injurious. Allchin and others present at the time dissented from this view, and on the whole, notwithstanding the use of starchy foods by certain German, American and other physicians as mentioned above, the general consensus of medical opinion is still that starchy foods are distinctly dangerous, that if used at all they should only be given in suitable cases, commencing with very small amounts at first, and that starch should not be given without some previous preparation such as prolonged heating to alter the character of the starch.

Patent foods containing unchanged starch are universally condemned even by those who recommend the use of cereal gruels, and almost without exception physicians agree that the main basis

of substitute feeding, in the case of infants who cannot obtain the only proper food—human milk—must be cow's milk. Various methods of modification of cow's milk are recommended—dilution with water, cereal gruels, &c. Some recommend fresh milk in full strength, some prefer to give boiled milk, and others dried milk.

Injurious Results of Feeding Infants on Starchy Food.

The statistics available in the annual reports of medical officers of health as a rule give little direct evidence as to the extent to which starchy foods are an important factor in infantile mortality, for two reasons, (1) frequently all forms of artificial feeding are grouped together in the returns, and (2) even when figures are given for the various kinds of food used for infants who have died during the first year of life there are usually no accurate figures available to show the comparative proportion of all babies fed on breast milk and on the various artificial foods, so that an absolute comparison is impossible.

The returns published by Dr. Hope (Liverpool), Dr. Niven (Manchester), Dr. Robertson (Birmingham), Dr. Tattersall (Salford), Dr. Greenwood (Blackburn), Dr. Newsholme (Brighton) and others in the annual reports on the health statistics of these towns, and statistics such as those quoted by Weiss (for Vienna), Divine, Forsyth and Armstrong, whilst indicating the appalling percentage mortality during the first year of life of bottle-fed babies as compared with breast-fed do not allow us to differentiate satisfactorily between different forms of artificial feeding.

The only inquiry on a fairly large scale, of which I am aware, which permits of this comparison is that carried out by Dr. Howarth in Derby. He ascertained the nature of the food given to 6,904 babies born between November, 1900, and November, 1903. Of 5,278 breast-fed children 368 died before reaching the age of 12 months, an infant mortality rate of 69·8 per 1,000. Of the 1,626 hand-fed children 321 died under the age of 12 months, a rate of 197·5 per 1,000.

The following table shows the results of Dr. Howarth's investigation as regards hand-fed infants:—

Food used.	Total Number fed on each Food.	Deaths.	D.R. per 1,000 fed on each Food.
Cow's milk or milk and water only	895	158	177
Condensed milk only	149	38	255
Bread, rusks, oatmeal, arrowroot, cornflour, sago, tapioca and mixed foods	159	40	252
Patent Food A	39	7	180
" " B	81	17	210
" " C	45	6	134
" " D	93	19	204
Various patent foods	164	36	220
All patent foods	(422)	(85)	(202)
Incomplete information	1	0	0
Totals	1,626	321	198

Patent food C was a farinaceous food in which the starch had been completely converted. A contained no starch and was a fair approximation in composition to dried human milk. D contained starch which had not been predigested. Excluding patent foods A and C, neither of which contained unchanged starch, there were 338 babies fed on various patent foods, the majority of which probably contained unchanged starch; amongst these 338 babies 72 died before reaching the age of 12 months, an infant mortality rate of 213 per 1,000.

Apart from the fact of the smallness of the numbers two other points must be considered, (1) the very high mortality amongst infants fed on cow's milk, which raises the question how far the starchy foods were responsible for the evil effects apart from the cow's milk, which was presumably given in most cases along with the patent foods, (2) were the infants fed on patent foods comparable in general condition of health to those fed on cow's milk, or were patent foods given to more delicate or weakly children? Also, in order to get a fair picture of the effects of starch, one would wish for information as to the proportion of cases in which the cow's milk was diluted with barley water or some simple cereal, and how far this affected the mortality in infants fed on cow's milk.

Looking at the figures with all caution, however, it would appear that Dr. Howarth's results indicate enhanced ill effects as regards infant mortality when babies are fed on patent foods containing starch; this idea is strengthened when we observe the figures for babies fed on even more unsuitable farinaceous food in the shape of bread, rusks, arrowroot, &c.

The high infant mortality from condensed milks also suggests that the figures for starchy foods are not accidental, but that a disproportionate amount of carbohydrate in the diet, whether of starch or of cane-sugar (as in condensed milk), adds materially to the risks to life for a hand-fed baby.

The figures, therefore, afford some confirmation of the opinion widely held by medical officers of health that starchy foods tend to increase infant mortality.

Thus Dr. Robertson, of Birmingham, in a special report in 1904 on infant mortality, says:—

> "Many of the patent foods are even more injurious than the condensed milks to very young infants, most of these consist mainly of wheat flour, and are but little, if indeed they are any, more suitable than ordinary cooked flour."

In Leigh, Lancs., in 1911, out of 95 infants dying from diarrhœa 23 had been fed on patent foods. Unless the proportion of babies fed on patent foods in Leigh differs very markedly from that in other districts this shows a marked incidence of the disease on infants fed on such foods.

It is probable, however, that to a great extent, the ill effects of a starchy diet during infancy manifest themselves more clearly in the second or some subsequent year of life. The evidence of clinicians on these ill effects is very striking.

Corlette, in the paper in which he recounts the physiological evidence in favour of the digestibility of starch by infants, says:

"The most important reason for the statement that starch is not digested or not properly digested in young infants rests on the observation that they frequently show signs of illness when fed on arrowroot, cornflour, &c., and that there seems to be clinical foundation for the statement that such a diet is apt to be followed by disturbance of health."

Cautley(2) says: "The magnificent babies of manufacturers advertisements only exist in imagination, or when seen in the flesh are simply fat and rachitic. Rickets and scurvy are undoubtedly often due to the use of these foods." He also states that many attacks of diarrhœa are produced by malted or starchy foods in the first few months of life, and mentions that 250 out of 547 collected cases of scurvy had been fed on proprietary foods. According to Divine a patent food fed baby is usually large, flabby, and rickety, and readily falls a victim to acute disease.

Lamb, although a believer in the power of the newborn infant to digest starch, says: "Too much carbohydrate may cause severe cholera-like diarrhœa and chronic metabolic changes like rickets and anæmia."

Scurvy.—A large number of writers, *e.g.*, Cheadle(2, 3), Cautley(2), Fussell, Goodhart and Still, agree in attributing the onset of scurvy in a very large proportion of cases to the use of starchy foods.

Cheadle(1) says: "Again, I have seen too frequently the most common mistake of all, perhaps, a puny bloodless child, with incipient rickets, eminently suffering from want of animal proteid and fat, owing to its inability to digest cow's milk, placed upon a purely farinaceous diet with the result of causing still further deterioration and inducing scurvy in addition to rickets."

Sullivan states that the use of proprietary foods and condensed milks produces more scurvy than all other methods of feeding, and Fowler's view with regard to proprietary foods is that "all are liable to produce scurvy." According to Colman, 19 out of 25 severe cases of infantile scurvy were taking some kind of dried infants' food as their staple diet.

Holt, referring to the collective investigation of the American Pediatric Society in 1898, showed that of 379 cases reported by 138 observers proprietary infants' foods had been used in 214 cases, whilst only 12 cases were reported in breast-fed infants.

Hutchison(1), Pritchard(1), Miller, and Shaw agree that with very rare exceptions only artificially fed babies are affected, and that proprietary foods are most likely to cause scurvy.

Still(2) points out the frequent connection of patent foods, given either with or without milk, with scurvy.

Rickets.—Cheadle(2) in recording in 1878 three cases of scurvy supervening on rickets said: "In all the diet had been such as is known to produce the rachitic condition with the greatest regularity and certainty, viz., one consisting almost entirely of farinaceous food without a sufficient quantity of milk, or other food containing an adequate amount of animal oil." (*See* also Cheadle(1).)

Holt says: "Rickets and scurvy have so frequently followed the prolonged use of starchy infants' foods, especially when given without the addition of fresh milk, that there can be no escaping

the conclusion that they were the active cause." In another place he says that rickets is exceedingly common in children reared upon the proprietary foods.

Pritchard(1) suggests that starchy foods may cause rickets by inducing intestinal catarrh and thus interfering with the digestion and absorption of proteins.

Hutchison(1), Miller, Fussell, Cautley(2), Goodhart and Still have also drawn attention to the association of rickets with the use of the starchy infants' foods.

Other troubles.—Cheadle(1) considers the use of starch in its simple unchanged state as most objectionable in the case of very young children, as it gives rise to acidity and flatulence. He also says that atrophy is often due to starchy food (starvation), and that anæmia occurs in all starch-fed children.

Robertson(2) considers infants' foods composed of farinaceous materials as most injudicious diet for young children. They act as irritants and gastro-intestinal troubles follow.

Sutherland(2) says diarrhœa is common in bottle-fed babies from the "too early and excessive use of starchy foods." He adds that an infant whose alimentary canal has been weakened by improper feeding during the winter months is much more likely to fall a victim to this disease in summer than one whose powers of resistance have been maintained at a high level.

Burnet(2) declares that the too early use of artificial and starch foods will lead, sooner or later, to infantile atrophy.

Hutchison(1) says that carbohydrates in excess are prone to fermentation with griping and diarrhœa as a result.

Goodhart and Still state that to give an infant of three months old a food containing a considerable proportion of starch—and this is the case with a large number of infants' foods—is a sure way of producing gastro-intestinal disorder of one kind or another, with its attendant distress and wasting.

Rietschel, although in favour of giving starch to infants from the second month on, admits that in certain circumstances specific disturbances of metabolism may occur, leading to atrophic conditions.

Explanation of Malnutrition and other disorders associated with the use of Starchy Foods.

Whilst there is some evidence that troubles such as diarrhœa may occur through fermentation of starch by bacteria in the intestine, and that such troubles may lead to weakening of the infant, and tend to swell the records of infant mortality, probably more often the ill effects are exhibited in more direct disturbances of nutrition.

Such evil results of starchy foods are no doubt due to the fact that the addition to milk of any considerable quantity of starchy food seriously affects the balance of the diet as regards the principal food elements, leading to a diminution in the proportion of fat, of salts, and of proteins to carbohydrates.

Cheadle(1), Hutchison(1), Robertson(3), Sheill and others have pointed out the dangers of fat deficiency, and showed that proprietary artificial foods are usually very deficient in this element.

Still(3) remarks that anything below 2 per cent. of fat is often associated with failure of nutrition, and probably 3 per cent. should be the minimum in most cases.

Chapin(1) says infants require 2 to 4 per cent. of fat, 4 to 6 per cent. carbohydrates, along with tissue builders, to ensure proper growth. Pisek suggests 2 per cent. to 4 per cent. fat, 6 per cent. carbohydrates, and 1½ per cent. proteins. Cole thinks a baby's food should contain 3½ to 4½ per cent. of fat. Cautley(2) says excess of carbohydrates in foods containing altered starch produces fatness rather than health and strength.

Deficiency of protein results, according to Cheadle(1), in checking of growth, softness and flabbiness of muscle, feebleness, pallor, decline in vigour, vitality and power to resist disease.

Pritchard and Colbeck point out that the highly complex proteid molecule (biogen), into which all assimilated food is ultimately resolved, undergoes continuous metabolism resulting in the discharge from the primary nucleus of atomic groups which are oxidised in the presence of oxygen. Under favourable conditions the final end products are simple bodies, carbonic acid, ammonia and water, &c., readily excreted. But with deficient vitality or insufficiency of oxygen larger atomic groups such as lactic, glycolic and oxybutyric acids may be discharged. The acid products of this incomplete metabolism require nitrogen for their conversion into harmless amido acids. An absolute or relative excess of non-nitrogenous material (carbohydrates) will promote the formation of free acids such as lactic acid, &c., which if not transformed into amido acids will seize sodium or potassium to satisfy their affinities.

In an infant absorbing a large excess of carbohydrates, and in the absence of an adequate supply of oxygen, and of protein, we should find an excess of lactates and other salts in the system. In the attempt to get rid of this excess hyperæmia and enlargement of the liver and spleen might be expected and evidence of skin activity (perspiration). Should the skin be thrown out of action (*e.g.*, by a chill) increased strain falls on the internal organs, the result being hyperæmia of mucous membranes with increased mucous secretion, shown clinically by attacks of bronchitis, tonsillitis, adenoids, &c. The fibrous tissues might also show signs of inflammation; bones and joints would become affected and the nervous system finally suffer (choreic symptoms). The authors proceed to state that the hypothetical picture thus drawn corresponds with the conditions actually occurring in infants under the conditions mentioned, and they point out that the treatment found effective is such as would be rationally prescribed for persons suffering from carbohydrate saturation.

Waste of Vital Energy.—Another aspect of the question appears to me not to have received the attention it deserves. The process of digestion is laborious, and Chapin(3) estimates that one-sixth of the entire force of the infant organism is needed to digest an ordinary meal. As has already been stated, mother's milk requires the least digestion and throws the least strain on the energy of the infant. Cow's milk throws a greater strain on the nervous and digestive system, and the addition of sugars, dextrin, starch, throws more and more work on the organism. A starch

decoction in which the starch has been partially converted demands less energy for its digestion and assimilation than a starch decoction which has been merely gelatinised by heating, whilst starch in unchanged form must demand a large amount of nerve and glandular work to secrete the ferments necessary to bring about complete digestion. Hubner (quoted by Edsall) has shown that a child fed on artificial food has to do more actual work to render that food a suitable nutriment than falls to the share of a breast-fed baby. Therefore, although physiologists have concluded that the addition of starch to an infant's diet may stimulate the production by the pancreas of amylolytic enzyme, there can be no doubt that this, in many instances, can only be accomplished by an expenditure of energy which the infant cannot afford without suffering in some other respect.

An article in the *British Food Journal*, VII., 1905, points out that starch being insoluble without the action of a special enzyme makes a demand on the digestive powers of the child which human milk certainly does not.

The hand-fed infant is sufficiently handicapped by having to cope with the digestion of cow's milk containing a foreign protein without having added to its food another foreign ingredient which requires elaborate and complex chemical processes to bring it into a stage suitable for assimilation.

The extra work required in digestion, along with the factor mentioned previously of the disproportion of fat, proteins, and salts to carbohydrates, will sufficiently account for nutritional disturbances, anæmia, rickets, scurvy, &c., which result from the use of starchy foods.

Barley Water.

Milk and Barley Water.—Owing to the liability of the casein of cow's milk to form an indigestible curd it has long been recommended that some substance should be added to the milk for the purpose of aiding the formation of a finer curd. Barley water has for many years been used for this purpose and has received the recommendation of the medical profession. The observations of Alexander and Bullowa indicate that in this capacity barley water acts as a protective colloid. They point out that casein is an irreversible coagulating colloid, whereas lactalbumin is a reversible or protective colloid. The lactalbumin stabilises and protects the casein from coagulation. In human milk there is a considerable excess of protective colloid whereas in cow's milk the ratio is heavily the other way. Human milk is scarcely coagulated by acid or rennin, and cow's milk may be made to act in a like manner by the addition of such protective colloids as gelatine, gum arabic, or cereal gruels, including barley water.

Although for many years medical men have strongly condemned the use of farinaceous foods in the diet of young infants it is probable that their recommendation of the use of barley water or other starch-containing gruels for modifying cow's milk has been to some extent responsible for the introduction of various patent foods containing starch and has been used as an argument for the harmlessness of starch in the diet of infants.* It is true

* *Lancet*, 1906, 1, 805; *British Foo*

that the methods recommended for preparing barley water usually involve prolonged boiling, which results in complete gelatinisation of the starch, whilst many of the proprietary infants' foods when prepared according to the directions on the packet contain starch in much less altered condition.

It should not be assumed, moreover, that such use of barley water is entirely devoid of harm. Still(1) says that even 1 to 2 per cent. of starch, as in barley water, is often harmful. Goodhart and Still point out that barley water has only an insignificant nutritive value in itself and though containing only about 1 per cent. of starch will sometimes disagree with an infant, producing or keeping up a troublesome looseness of the bowels; some infants being very sensitive to it. Verley (*British Medical Journal*, 13th April, 1902) records a case in which wind and diarrhœa were so caused.

Cheadle(1) expresses doubts as to its value, says it tends to produce flatulence in small infants, and considers pure boiled water preferable as a diluent of cow's milk.

Pritchard(1) declares that weak barley water (made from "pearl" barley rather than "prepared" barley) should not be given before the second month of life.

Overend says barley water is not harmful if the starch be kept *below* 1 *per cent.*

Southworth says the proportion of barley should not be greater than one full teaspoonful to each pint of water, which is only half the amount commonly advised. But, as Cheadle(1) says, barley water is often not well made; it may vary very considerably in the percentage of starch contained. Ladd found variations from 0·64 per cent. to 6 per cent. according to the formulæ of six different writers.

Wynter Blyth's analysis quoted by Hutchison showed only 0·39 per cent. Miller says that as usually prepared it contains from 0·5 to 2 per cent. of starch. Corlette using the same recipe in eight experiments found variations from 1·84 to 2·34 per cent.

Ladd and Lister have pointed out that, theoretically, barley water should be used in a more dilute form for young than for older infants, whilst according to the usual methods adopted the reverse is the case, the barley water decoction being made the same strength all through, and less and less being added to the milk as the child grows older.

Even so far as regards the lessening of curd it is doubtful whether barley water is so efficacious as is supposed. Fordyce says it has not much more effect *qua* curd than plain water, whilst Poynton declares that boiled water is better than either barley water or lime water.

Cautley(3) says barley water has little, if any, more effect on the curdling of milk than a like quantity of an equally alkaline water. He thinks it is chiefly valuable for its soothing effect on the mind of the mother, who has great belief in the nutritive value of barley water, and thinks her child is being starved on a diet of milk and water.

In view of the possible ill effects of even such small quantities of starch, and in view of the considerable amount of evidence as

to the usefulness of citrate of sodium, which has been recommended by Poynton and others, for the purpose of securing a finer and lighter curd, medical practitioners might find it advantageous to prescribe this material rather than barley water as a milk diluent.

Conclusion.—As the result of my inquiry I am of opinion that foods containing unchanged starch or starch altered only by heating should not be given to babies under seven months of age except on the advice of and under the supervision of a medical man.

Further, that similar precautions should be observed with regard to the use of barley water.

SECTION V.

Statements, in Labels or Advertisements, which are Inaccurate or Liable to Mislead.

The title "infants' food" itself is inaccurate with regard to many of these proprietary articles, as none of the starchy foods are really suitable alone as food for infants. At the best, all that can be said is that in some cases they may possibly be tolerated by infants when used in comparatively small amounts mixed with milk, and that in certain circumstances it may be found desirable by the physician to substitute a mixture of this kind for the infant's natural food.

As a rule some recognition of the limited usefulness of these "foods" is shown in the wording of the directions for preparing the foods for infants. In the great majority of cases it is expressly directed that milk is to be used along with the food, and on close examination of the directions it is obvious that, if these are properly followed, milk forms the main basis of the diet.

The value, however, of this declaration as to the necessity of using milk is almost completely neutralised by the emphatic insistence, in other portions of the reading matter, on the special suitability of the particular brand as a food for infants. For a mother may naturally ask herself why, if the proprietary article is such a splendid food for a baby, she should diminish the valuable feeding effect by mixing milk with it. This is especially likely to be the case when the mother is poor and can ill afford the price both of the food and of milk to go with it.

Another factor tending to the omission of the milk is the opinion frequently found to exist among a certain class of poor people, that milk is hardly a food, but more of a drink, with little nourishment in it. As the health visitor for Wakefield says in her annual report for 1909, "Nothing will convince the average old-fashioned grandmother, that milk alone is sufficient for an infant under eight months." And she points out, if a child is being fed on milk only, neighbours often tell the mother she is starving it and advise the use of some form of "solid" food.

The evidence of health visitors and others goes to show that mothers do sometimes omit the milk, or use it in smaller proportion than laid down in the directions, or use a dilution of skimmed condensed milk instead of full cream cow's milk.

Further, several brands of infants' foods go to the length of suggesting that milk is not necessary, by directing that the

food can be made up with milk *or water*. It would be natural, therefore, for a poor mother to save the cost of milk in such cases.

Foods No. 16, 51, 58, 60 are directed to be made with milk or water. As regards 68, it is stated specifically that no milk is required; as to 73, it is stated that it requires no addition but water; whilst in 32 and 36, the directions suggest the use of only a small amount of milk, "a tablespoonful or more." Of these, Nos. 16, 58, 60 contain unaltered starch to the extent of 53 per cent. to 73 per cent.; No. 32 contains 65·6 per cent. of starch; No. 36 contains some unaltered starch but a large proportion of hydrolysed starch products, whilst Nos. 68 and 73 consist mainly of mixtures of dried milk with hydrolysed starch products. Obviously none of these correspond to milk in composition. (*See* pages 82, 83.)

But apart from the definite statement that milk is not required in the preparation for use of these foods, many brands contain statements which so plainly suggest that the food is of itself sufficient for infant nourishment that it is difficult to acquit the proprietors of the intention to lead users to feel that no advantage is to be gained by adding milk to the food, whilst, if challenged, they could point to the printed directions indicating that the use of milk is advised.

What other inference can be drawn from such statements as the following:—

"Containing *everything necessary* for the full growth of the body" (No. 1).

"Children require no other than '. . . . .' food to ensure their *perfect nourishment* and *healthy growth*" (No. 1).

The suggestion that no other food is required for perfect nourishment is frequently met with in other forms. The following are examples:—

"Containing all of the elements necessary to sustain life indefinitely from infancy to old age in perfect health" (No. 13) (yet this article is extremely low in fat and proteins and contains 75 per cent. of starch).

"A perfect food for infants . . . . containing . . . . *all the necessary elements* for the building up of healthy muscle, flesh and bone" (No. 18).

"Presents *every* physiological requirement" (No. 2).

"Possesses *every* requirement necessary for children brought up wholly or partially by hand" (Nos. 20, 26, &c.).

"It has been our aim to make a *perfect substitute* for the breast milk of a healthy and vigorous mother . . . . This we now have done" (No. 2).

"It contains *all the nutritive elements* of human milk—carbohydric, albuminous and saline—in approximately the same proportions in which they exist in this secretion, and is therefore capable of supplying an equivalent of natural nourishment" (No. 26 and others).

"Containing *all the elements* required by infants" (No. 40).

"A reliable food for infants. It *is complete in itself*" (No. 68).

In the following series the foods are compared favourably with mothers' milk:—

. . . . this food is *practically identical with*, and contains all the life building constituents of mothers' milk (No. 73. Mr. Baker's analysis shows that this food is a mixture of hydrolysed starch products, dried milk, cane sugar and malt flour, and although less objectionable than some other infants' foods is certainly not practically identical with mothers' milk).

"The best substitute for mothers' milk" (No. 16).

"The most perfect substitute for mothers' milk" (Nos. 20*b*, 20*e*, 25, 26*b*, 39, and others).

"A perfect substitute for mothers' milk" (Nos. 20, 26*a*, 36).

"A perfect substitute for breast milk" (No. 2).

"Contains the same nourishing substances as mothers' milk and in the same proportions" (No. 54).

"Infants fed with the . . . . made thin in water and salt to pass through the feeding bottle *thrive better upon it than on nurses' milk*" (No. 58).

"Contains *all the* ingredients required for building up a sound and vigorous constitution" (No. 9). On the label of this brand is a picture of a sturdy child holding a band inscribed with the words "*My sole support.*"

The climax, I think, is reached in No. 33 which is declared to be "*Greatly superior* to a healthy mother's milk," although 73·6 per cent. of starch is present.

It is difficult to believe that such statements as those quoted above are not intended to convey the idea that the food in the packages so labelled is by itself and without the addition of milk a suitable diet for an infant.

The extravagant claims of special superiority found on many labels also tend to suggest the fitness of the food by itself as a diet for infants. Such are the following:—

"Most nutritious food in the world" (No. 3).

"Most nutritious and least costly for babies" (No. 9).

"Most nutritious food for infants" (No. 7).

"Most nutritious food known" (No. 13).

"Best and cheapest food for infants" (Nos. 20*b*, 20*d*, 20*c*, 26*b*, 26*d*).

"Most invaluable food for infants . . . . that has yet been produced" (Nos. 21, 21*a*).

"As food for infants deprived of the breast we need only refer to the testimonials to prove its superiority over any other diet ever offered to the public" (No. 14).

Other labels claim special value for the food on account of supposed richness in mineral matter:—

"Strengthened with extracted wheat phosphates" (No. 3).

"Rich in those phosphatic and nitrogenous constituents so necessary for the formation of flesh and bone" (No. 44).

"The food is rich in phosphates" (No. 63).

"Develops bone, muscle, teeth, brain, and enriches the blood" (No. 3).

"Makes blood, bone, brain, and muscle" (No. 7).
"Forms bones and nerves as well as muscles" (No. 29).

Few of the samples contain mineral matter in as large a proportion as is present in the solids of human milk. (*See* p. 11.)

"Natural food for babies" (No. 9) is a misleading title for a food which contains no milk and contains 68 per cent. of starch.

The statement used with reference to No. 13—"the food that digests itself"—is inaccurate in view of the large proportion of unaltered starch (75 per cent.) contained in the product, and such a statement is likely to lead purchasers to form an erroneous impression of the value of the food in the diet of infants.

No. 29 has a similar statement—"A self digesting farinaceous diet." Although there is active diastase present, yet if the food is prepared according to directions no material conversion of the starch takes place.

No. 17 is entitled a "digestive food for infants."

The use of the word "malt" or "malted" also tends to suggest the idea of complete digestion or conversion of the starch. One brand contains the statement "Contains malt, 1 grain of which digests 2,000 grains of starchy food" (No. 31). Mr. Baker's investigation failed to find any soluble diastase and even if any had been present, when the food was prepared according to directions no material starch conversion would occur. In Nos. 16, 21, 26, 28, 31, 32, 33, and 44, and also in many other foods not examined by Mr. Baker, the word malted appears in the title and is no doubt meant to give the impression that either the starch has already been converted by diastase, or sufficient active diastase is present to convert all or most of the starch. Yet the only claim some of them have to the title malted is that some dried malt extract or a small amount of ground malt has been added, and even in those cases in which active diastase is present, when the food is prepared according to the directions, no substantial amount of starch conversion will occur (cf. p. 56).

The word "milk" is also used in some of the titles in a way not altogether justifiable. No. 16 is called a malted "milk" food, but it contains 60 per cent. of starch and merely a small quantity of added lactose. Nos. 68 and 73 also use the word "milk." These both contain substantial amounts of dried milk, but as regards the proportion of fat and in other respects they are not exactly equivalent to human milk or to cows' milk.

No. 14 is claimed as "a substitute for cod liver oil." As only 1 per cent. of fat is present in this food, and as the chemical composition does not show the least resemblance to that of cod liver oil, it is difficult to understand how even the proprietors can discover the slightest justification for such a statement.

There is a sardonic humour about the warnings in the following statements:—"Avoid foods composed of starch only" (No. 35); "Most of the so-called infants' foods are mere mixtures of starchy meals and quite unfit for the delicate digestion of infants" (No. 44), in view of the fact that No. 44 contains 62·6 per cent. of starch, and as prepared for food the starch is gelatinised but otherwise unchanged. No. 35 has not been

specially examined by Mr. Baker, but the following analysis by Dr. Monier-Williams shows that it is a similar preparation and contains 59·9 per cent. of starch:—

Prepared Malted Food (No. 35).

	Per cent.
Starch	59·9
Reducing sugars as dextrose	2·5
Cane sugar	10·8
Proteins	9·3
Ash	1·8
Fat	0·9
"Cellulose"	2·5
Moisture	9·2
	96·9

Saccharifying diastase (Lintner) ...	15·5°
Liquefying diastase	Strong.
Difference between matter soluble in water at 15° C. and 35° C. ...	2·6 per cent.

It is difficult to realise the implicit faith put by many poor people in printed statements made on labels or advertisements. Many think that the authorities would not allow anything untrue to be published, and that the claims made for proprietary foods may therefore be absolutely relied on.

Health visitors frequently experience great difficulty on this account in persuading mothers to abandon the use of unsuitable food. In the report of the county medical officer for Warwickshire for the fourth quarter of 1911 one of the county health visitors refers to the difficulty she has experienced in persuading mothers that the highly coloured statements in many advertisements about patent foods are not to be implicitly relied upon.

In the annual report for 1910 of the medical officer of health for Finsbury it is stated that a baby six weeks old was fed on an unsuitable patent food. The father had seen it advertised as being used by a Royal household, and "what was good enough for Royalty was good enough for his young ones."

It is considerations such as these that have led many people interested in public health questions to a belief in the necessity for local and central authorities to possess greater powers to control exaggerated, inaccurate or misleading statements.

SECTION VI.

Conclusions and Administrative Considerations.

The general conclusion to be drawn from the evidence summarised in this report is that many proprietary infants foods are not in fact suitable for the feeding of infants under 7 or 8 months of age and that they may cause serious injury.

The evil results may be due to: (*a*) presence of starch in greater or less amount; (*b*) presence of excess of carbohydrates—starch or sugar—with relation to the protein and fats; (*c*) deficiency in fat.

Medical authorities and sanitarians have deplored the increasing use of such unsuitable preparations for the food of infants, and medical officers of health and others (through health visitors and by means of printed warnings circulated to mothers) have indicated the importance which they attach to the prevention, as far as possible, of the use of such articles.

Public analysts have frequently reported on the results of analysis of these foods and have commented strongly on the lack of correspondence between the analytical findings and the claims made in the advertisements, but as a rule local authorities have not felt justified in prosecuting the vendors. It seems to have been generally considered that the existing law was not wide enough to allow successful legal action to be taken to stop the sale of unsuitable articles under the title of infants' foods. A recent case, however, suggests that in some circumstances the existing Sale of Food and Drugs Acts may be successfully invoked.

The Rutland County Council, at the instance of the county medical officer, in 1912 prosecuted a chemist and druggist for selling as an infants' food a preparation which was not of the nature, substance and quality of the article demanded, inasmuch as it contained 70 per cent. of starch. The magistrates convicted, but as it was a first offence imposed merely a nominal fine.*

Although this prosecution was successful, in Liverpool proceedings were taken unsuccessfully in connection with a sample certified by the public analyst to contain 64 per cent. of starch, although the tin was labelled "free from all adulteration, such as starch, which renders most foods for infants so injurious to children under six months old."† The unsuccessful result in this case deterred the local authority from taking proceedings in similar cases, which were reported by the public analyst.

Various suggestions have been made from time to time as to the action which should be taken to deal with this matter:

A.—At the National Conference on Infantile Mortality in 1906 the following resolution was passed:—

> "That all preparations offered or sold as food for infants should be certified by a Government analyst as non-injurious, and that each packet should contain its analysis."

Some local authorities have passed similar resolutions and forwarded them to the Board with a view to legislative action being taken to carry them into effect.

B.—The County Councils Association have made the following suggestions with regard to proprietary medicines: although the Association did not suggest their application to proprietary infants' foods also, it is perhaps worth while setting them down,

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* *British Medical Journal*, June 15th, 1912; *Grantham Journal*, May 11th, 1912.

† Reports of the Public Analysts and Medical Officer of Health for Quarter ended 31st March, 1911.

as with certain alterations they might be applicable to infants' foods:—

(*a*) "That for medicines which are supplied otherwise than upon medical, dental or veterinarian prescriptions, no condition of sale short of publication on each packet of medicine of the name and proportion of each of its ingredients should be permitted.

(*b*) "That the label should be made to constitute a warranty and that false description with regard to the ingredients whether on the label or in an advertisement should be made an offence.

(*c*) "That the provisions of the Sale of Food and Drugs Acts should be applied to proprietary medicines."

C.—Suggestions have also been made by Pritchard(4) and others that provisions similar to those of the Fertilisers and Feeding Stuffs Act might be applied to infants' foods.

D.—It has also been suggested that infants' foods containing starch should be required to bear declarations, such as, "this food should not be given to infants under six (or nine) months old except on medical advice," or the still more drastic remedy of the application of a law such as the Roussel law in France, which prohibits the administration of solid food to a child under 12 months without the express direction of a medical man.

Other suggestions have been made. For example, Overend proposes that all proprietary infants' foods should bear on the label "the average composition of the food and its calorie value when prepared according to the general directions," also statements as to the quantity of the food required at different age periods; Robertson(1) declares that the general and unrestricted sale of such preparations as food for infants should be prohibited, or at least that they should only be sold by qualified pharmacists, who would first inquire as to the age and condition of the child; Blackham puts forward the suggestion that the use of undigested farinaceous foods for infants less than seven months old should be prohibited.

A.—There would be difficulty in putting into practice the first part of recommendation A, as a food might be suitable for an infant of nine months of age and quite unsuitable for one of three months, and the conditions as to method of preparation, proportion used, &c., might affect very markedly the question as to injuriousness.

As regards the second part of this recommendation, a statement on the package as to the analysis of the food would probably be a desirable requirement. But difficulties arise as to the form such a statement should take. To translate analytical results into precise yet simple language is not easy. To give the amount of fat, mineral matter, water, and of added sugar, if any, would be easy, but difficulties arise as to carbohydrates and proteins. As regards proteins a declaration as to the "total amount of nitrogen" might be misleading unless "albuminoid" and "non-albuminoid" nitrogen were differentiated. If the amount of protein had to be stated it would be necessary to lay down some rule as to the factor to be used, or perhaps to dictate the method of analysis.

As regards carbohydrates the matter is even more complicated, as infant foods may contain cane sugar, dextrose, maltose, lactose, cellulose, and unaltered starch as well as dextrins. The exact determination of the amounts of each of these would be difficult. If a declaration on a packet of the result of analysis of the contents is to be of practical use it would need to be framed in such a way as to indicate the maximum amount of sugar, starch, &c., and the minimum amount of protein and fat contained in the food. Such information might not convey much to the mind of the ordinary purchaser, but it would enable the medical adviser to explain to mothers which were foods to be avoided for babies and to state why they were unsuitable.

C.—As regards (C), some provisions of the Fertilisers and Feeding Stuffs Act of 1906 might be usefully adapted to deal with the question of infants' foods. I understand this Act has been found successful in dealing with cattle foods and fertilisers.

This Act deals, perhaps, with substances, on the whole, simpler from the analytical point of view and also from the point of view of nutrition than are some of the infants' foods.

The important provisions are as follows:—

Fertilisers must be accompanied by a declaration of their principal constituents, viz., total nitrogen, soluble phosphates, insoluble phosphates, and potash (Section 1 (1)).

Cattle foods or poultry foods must be accompanied by a statement as to whether they have been prepared from one substance or seed or more than one, and when artificially prepared, by a declaration of the amount of oil and of albuminoids.

Section 1 (3) of the Act might be adapted to infants' foods; where an article is described as having been prepared from any particular substance or from two or more substances, there shall be an implied contract that nothing has been used but the substances mentioned.

It would probably not be practicable to require in all cases a declaration as to the substances from which the infants' foods were made, but if the manufacturers voluntarily make a declaration it should be a true one.

Sub-section 4 of Section 1 states that on the sale of an article for food for cattle or poultry there shall be implied a warranty by the seller that the article is suitable to be used as such. Presumably a civil action for damages could be sustained under this section, and if applied to articles sold as infants' foods which contained considerable amounts of starch some protection to the purchaser might be given.

D.—The proposal to require declarations (D) would involve difficulties. Some authority would have to be responsible for deciding which brands must bear the declaration, and this would in practice mean the analysis by a chemist on behalf of the Government of every brand on the market and of each new brand as it appeared. This practically amounts to a similar Government guarantee to that suggested in A.

Some advantage might be expected from a requirement that all infants' foods containing, say, more than 25 per cent. of starch should bear a statement printed in large and legible type to the effect that "this food should not be given to infants under the age of seven (nine) months except on the advice of a medical man."

The difficulty as to this, however, is that the harmfulness of the food would depend to a great extent on its method of preparation and on the proportion of milk used in preparing the food for the infants. For instance, a teaspoonful of a food containing 50 per cent. of starch in a baby's bottleful of milk would not give as much starch in the resultant mixture as a tablespoonful of another food, containing only 25 per cent. of starch, in the same amount of milk.

Probably none of the suggested methods of exercising control over unsuitable infants' foods would be entirely satisfactory unless steps could be taken to prevent the mischievous effects of inaccurate titles or misleading statements in placards, advertisements, pamphlets, or directions for use accompanying infants' foods.

There is evidence to show that extravagant statements made by manufacturers and dealers with regard to the value of the infants' foods they sell do in fact mislead many poor people to entertain an exaggerated belief in the virtues of these foods and to use them for very young infants for whom they are entirely unsuitable or even injurious.

It has been suggested that to assist in securing adequate control it might be desirable to require all packages containing articles intended for sale or use as infants' foods to bear the name of the manufacturer or person responsible for putting the article on the market.

FRANCIS J. H. COUTTS.

APPENDIX I.

REGULATIONS IN OTHER COUNTRIES.

COMMONWEALTH OF AUSTRALIA.

Imports into Australia are governed by regulations made under the Commerce (Trade Descriptions) Act, 1905. The current regulations are contained in Statutory Rules, 1913, No. 145, dated 15th May, 1913, which rescind previous Statutory Rules on the same subject.

The requirements regarding infants' foods are as follows:—

Trade Description.—General Requirements.

7. The trade description to be applied in accordance with this Part shall comply with the following provisions:—

(*a*) It shall be in the form of a principal label or brand affixed in a prominent position and in as permanent a manner as practicable to the goods, or where affixture to the goods is impracticable, to the coverings containing the goods; and

(*b*) It shall contain in prominent and legible characters a true description of the goods, and the name of the country or place in which the goods were made or produced; and

(*c*) In cases where any weight or quantity is set out, it shall specify whether the weight or quantity so set out is gross or net.

Trade Description.—Additional Requirements in certain cases.

8. In the case of the following goods, the trade description shall, in addition, comply with the following provisions:—

* * * * * * *

(*b*) In the case of foods for infants, if the food is not suitable for general use for infants under the age of six months, the trade description shall include, in legible character and conspicuously displayed, the following words, namely, "Not suitable for infants under the age of six months."

EXTRACT FROM REPORT OF INTERSTATE DEPARTMENTAL CONFERENCE ON UNIFORM STANDARDS FOR FOOD AND DRUGS IN THE COMMONWEALTH OF AUSTRALIA, 1910.

19. *Infants' Food.*

(1.) Infants' food shall be any food described or sold as an article of food suitable for infants. It shall not contain any woody fibre nor any mineral substance which is insoluble in acid.

(2.) In the principal label attached to every package of infants' food which contains starch, or which, when prepared as directed by any accompanying statement or label, does not conform approximately in proportional composition to human milk, shall be written the words: "Not suitable for infants under the age of six months," in bold-faced sans seriff capital types. The said words shall form the first line or lines of the said label, and no other word shall be written on the said line or lines.

EXTRACT FROM REPORT OF ROYAL COMMISSION ON UNIFORM STANDARDS FOR FOOD AND DRUGS, COMMONWEALTH OF AUSTRALIA, 1912.

Infants' Foods.

52. Conference Recommendation 19 (2) (Infants' Food) requires that infants' foods which contain starch, or which, when prepared as directed by the vendors do not conform approximately in proportional composition to human milk, shall be labelled: "Not suitable for infants under the age of six months." Attention was drawn to the recommendation by a witness who represented a certain infants' food, and the proposed labelling (which is in actual use under State regulations) was objected to. It was pointed out by this witness that his food contained only about 1 per cent. of starch; that so very small a proportion of starch could not be alleged to be harmful; that the food had for many years been widely used for infants of all ages, including those still in the first six months of life; and many statements made by physicians of repute were tendered in evidence, in which the usefulness and harmlessness of this food to young infants was advocated. The evidence given need not be disputed as far as it goes, but it is necessary to note that the feeding of infants under the direction and under the observation of competent physicians may probably be widely distinguished from the feeding commonly carried out by parents without special advice, and for the most part without any instructions. But the question really raised, and which needs answer in relation to almost all infants' foods, would appear to be as to the meaning of the word "starch" as used in the recommendation. All of the foods referred to are made from starch in its natural form, among other ingredients. In the course of digestion starch is submitted to the action of digestive ferments which change it ultimately into sugar, which ultimate result is reached through stages in each of which the altered starch is no longer called "starch" but by names which definitely indicate its modified properties. These

digestive ferments can also be supplied to the starch artificially, that is to say, before it has entered the digestive apparatus, and to do this so as to secure the desired alteration of the starch is one of the conditions of production of such infants' foods. Now, although the term "starch" is not applied to the substances produced from it which are intermediate between starch and sugar, they are all collectively referred to as "converted starch." It appears, therefore, that the statement tendered by the witness needed modification, and that it would have been more accurate had he said that the food under notice (and all other such foods) contained no more than 1 per cent. of unconverted starch. Now, whether the word "starch" as used in the recommendation does or does not cover all forms of starch, converted or not converted, is one question, and it may be discussed; but that it was intended to cover all of them seems certain.

53. Evidence given by the Professor of Physiology in the University of Melbourne (Dr. W. A. Osborne) was that infants' foods ought not to contain any carbohydrate except lactose, and that it was a mistake to differentiate between starch and its products intermediate between it and sugar. The reason he mentioned was that all such products easily undergo alcoholic fermentation and favour the growth of harmful bacteria in the digestive canal, whereas milk-sugar resists alcoholic fermentation and does not undergo it. Milk-sugar does undergo fermentation but the result is quite different; lactic acid alone is produced, and there is good reason for regarding lactic acid as a useful preservative which not only does not favour the harmful bacteria just referred to above but is actually powerful to restrain their appearance. Here, then, are two questions which would appear to need discussion and answer; one on the meaning to be attached to the word "starch" in the recommendation mentioned, the other as to the object sought by the recommendation.

EXTRACT FROM REPORT OF THE COMMONWEALTH AND STATES OF AUSTRALIA SECOND CONFERENCE ON UNIFORM STANDARDS FOR FOODS AND DRUGS, 1913.

19. *Infants' Food.*

(1.) Infants' food is any food described or sold as an article of food suitable for infants. It shall not contain any woody fibre, nor any mineral substance which is insoluble in acid, nor any preservative substance.

Labelling.

(2.) In the label attached to every package of infants' food which contains starch, or which, when prepared as directed by any accompanying statement or label, does not conform approximately in proportional composition with human milk, shall be written the words, THIS FOOD SHOULD NOT BE GIVEN TO INFANTS UNDER THE AGE OF SIX MONTHS EXCEPT UNDER MEDICAL DIRECTION, in bold-faced

sans-serif capital letters of not less than six points face measurement. The said words shall be the first words of the label, and no other word shall be written on the same line or lines.

(3.) Any infants' food which contains any starch of which fifty parts or more per centum remain unconverted when the food has been prepared as directed shall be labelled NOT SUITABLE FOR INFANTS, in bold-faced sans-serif capital letters of not less than six points face measurement.

NEW SOUTH WALES.

EXTRACT FROM REGULATIONS DATED 1912, UNDER NEW SOUTH WALES PURE FOOD ACT, 1908.

Regulation 31.—*Standards for Infants' and for Invalids' Foods.*

(1.) Infants' food shall be any food described or sold as an article of food suitable for infants. It shall not contain any woody fibre nor any mineral substance which is insoluble in acid.

(2.) No person shall sell any package of infants' food which contains any starch, or which, when prepared as directed in any accompanying instruction, does not conform approximately in proportionate composition to human milk, unless there be written on or attached to every package containing any such food a statement or label in which is written in bold-face sans seriff capital letters of not less size than eight points face measurement the words: "Not fit for infants under the age of six months," in dark ink on a light ground. No other word shall be written on the same line with the said words.

QUEENSLAND.

"EXTRACT FROM REGULATIONS DATED 1912, UNDER THE QUEENSLAND HEALTH ACTS, 1900 TO 1911.

23. *Infants' Food.*

1. Infants' food shall be any food described or sold as an article of food suitable for infants. It shall not contain any woody fibre nor any mineral substance which is insoluble in acid nor any preservative.

Labelling.

2. In the principal label attached to every package of infants' food which contains starch, or which, when prepared as directed by any accompanying statement or label, does not conform approximately in proportional composition to human milk, shall be written the words: "not suitable for infants under the age of six months," in bold-faced sans seriff capital types. The said words shall form the first line or lines of the said label, and no other words shall be written on the said line or lines.

TASMANIA.

Extract from Regulations under the Food and Drugs Act, 1910.

19. *Infants' Food.*

1. Infants' food shall be any food described or sold as an article of food suitable for infants. It shall be composed of food substances modified, prepared or compounded so as to possess special nutritive and assimilative properties which render it specially suitable for use as food for infants. It shall not contain any woody fibre nor any mineral substance which is insoluble in acid.

Labelling.

2. In the principal label attached to every package of infants' food which contains starch, or which, when prepared as directed by any accompanying statement or label, does not conform approximately in proportional composition to human milk, shall be written the words: "Not suitable for infants under the age of six months," in bold-faced sans seriff capital types. The said words shall form the first line or lines of the said label, and no other words shall be written on the said line or lines.

3. There shall be written in the principal label attached to any package containing any article of food described as or purporting to be infants' food, a statement of the ingredients contained in it, and of the properties or grounds on which the claim of special suitability for infants is based.

This regulation shall come into force on the 1st March, 1912.

SOUTH AUSTRALIA.

Extract from Regulations under the Food and Drugs Act, 1908.

Regulation 16.—*Infants' Food.*

Infants' food shall be any food described or sold as an article of food specially suitable for infants of or under 12 months of age. It shall contain no woody fibre nor any mineral substance which is insoluble in acid. Unless described or sold specifically as food suitable only for infants of or above the age of six months, infants' food shall, when prepared as directed by any accompanying statement or label, contain no starch, and shall contain the essential constituents of, and conform approximately in proportional composition to, human milk.

APPENDIX II.

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II. On the analysis and composition of some Proprietary Foods for Infants: By Mr. Julian L. Baker, F.I.C.

Introductory.

Although infants' foods are increasingly used in this country and America relatively little is known of their composition. A few analyses have been published at different times but the analytical methods employed in most cases were crude, and important constituents, such as starch and carbohydrates, were obtained by "difference." The fullest analyses so far published appear in the Report of the Connecticut Agricultural Experiment Station; Food Products, 1908, 599-606. Some 23 foods were examined and it is stated that an attempt to separate the carbohydrates proved unsuccessful. The lactose was determined by the unreliable mucic acid method, and the values so obtained are claimed to be "suggestive rather than absolute," nevertheless, in common with all the other constituents estimated, the values

are recorded to the second decimal place. McGill (Canadian Department of Inland Revenue, Bull. 59) has also analysed a number of infants' foods. He estimated water, fat, proteins, mineral matter, and amount soluble in alcohol and water. Starch was determined by difference. In some cases figures are given for maltose, lactose, and cane sugar. R. Hutchison (Food and Principles of Dietetics, 3rd ed. 1911, 467-469) has published analyses of many of the infants' foods used in this country. This author estimated water, protein (by 5·7 factor), fats and mineral matter; carbohydrates being determined by difference and no distinction being drawn between starch and soluble sugars. He gives the composition of the foods, but these could not have been deduced from the analytical figures recorded. Infants' foods have thus, to a great extent, escaped the scrutiny of analysis. This is to be regretted considering the rôle many of these preparations play in the infant life of this country and the exaggerated claims made for them as foods, or as substitutes for human milk. The estimation of moisture, fat, proteins, undifferentiated carbohydrates (by difference) and mineral matter is obviously insufficient for the proper examination of any food. In the writer's opinion it is highly important to know exactly what carbohydrates are present and the approximate composition of the food as prepared for use. Thus a few of the foods (*e.g.*, Nos. 56 and 83) when analysed in the dry state contain large quantities of starch, but this undesirable constituent is altered for the most part to a mixture of easily assimilable maltose and malto-dextrins during the process of preparation. To condemn such a food on its analysis before being prepared for use would be unjustifiable. As many of the foods are prepared by mixing with milk or water at such temperatures that the whole of the starch is gelatinised, it was clearly a necessary feature of this enquiry to examine carefully the samples when made up according to directions.

Methods of Analysis.

Starch.—The starch was estimated by Thorne and Jeffers' modification (Analyst, 1909, *34*, 332) of C. J. Lintner's polarimetric method (Zeitsch. Ges. Brauw. 1907, *30*, 199-111). 5 grms. of the finely ground material were triturated in a mortar with 10-15 cc. of water, followed by 15-20 cc. of hydrochloric acid of sp. gr. 1·15 added in quantities of 5 cc. at a time. The starch quickly becomes a viscous mass and this in the course of a few minutes becomes thin. It was allowed to stand for half-an-hour and then transferred to a 200 cc. flask containing 10 cc. of a 4 per cent. solution of phosphotungstic acid and 20 cc. of hydrochloric acid of sp. gr. 1·15. The mortar was washed out with hydrochloric acid of sp. gr. 1·1 and the flask made up to the volume with acid of the same strength. After being well shaken and again allowed to stand for at least half-an-hour the liquid was filtered and polarised in a 200 mm. tube at 20° C. using a Schmidt and Haensch polariscope and white light. The percentage of starch (P) is calculated from the reading (R) by the formula:—

$$P = \frac{R \times 40}{11{\cdot}6}.$$

This formula involves the assumption that soluble starch has a specific rotatory power of +200°, a value probably somewhat too high as will be seen from the following analyses of pure starches which were made to test the reliability of the method :—

Starch, per cent.	Moisture, per cent.	Mineral matter Protein and Fibre, per cent.	Starch, per cent.	Total.
Potato	17·96	·04	80·4	98·4
Soluble potato starch ...	16·42	—	81·4	97·8
Wheat	13·82	·38	85·56	99·76
Soluble wheat starch ...	11·86	—	85·56	97·42
Maize	11·62	·53	84·35	96·5
Tapioca	12·66	—	84·52	97·18

The soluble wheat and potato starches give low results, due probably to a trace of dextrose which is always formed during preparation. Test mixtures of starch and casein were examined and the results proved satisfactory. The limit of accuracy of this method may be placed at ± 0·5 per cent.

It is obvious that the readings should be corrected for other optically active bodies, if present, in the foods, thus cane sugar is inverted by the acid treatment and the reading due to starch, if uncorrected, would be low. Dextrose and lactose may be assumed to retain their + reading and have also to be corrected for if present. The corrections are as follows :—

Cane sugar per cent. × ·028 is added to the reading
Dextrose ,, ,, × ·07 ,, deducted from ,, ,,
Lactose ,, ,, × ·07 ,, ,, ,, ,, ,,

} before using the formula $P = \frac{R \times 40}{11·6}$

In the cereal foods starch was determined—

(1) On the original food.
(2) On the de-fatted food.
(3) On the insoluble residue after extraction with cold water.

In those cases in which it was suspected that the starch present had been rendered partially soluble by heating or otherwise, as for example in those foods principally consisting of baked flour, the starch in addition to being estimated on the food itself was again estimated on the portion insoluble in water. The difference between the two values so obtained may be regarded as a measure of any starch rendered soluble by heating, provided the food does not contain the diastase of a malted cereal which would dissolve some of the starch during the period of aqueous extraction.

Hydrolysed Starch Products.—These products comprise the mixture of maltose, malto-dextrins and dextrins obtained by the action of diastase on starch, all of which are soluble in water and are optically active. In some of the foods examined (*e.g.*, Nos. 2, 36, 54, and 68) there is present what is probably an evaporated starch or flour conversion consisting of a mixture of carbohydrates obtained by the action of diastase on starch. As a result of this process the starch is

changed into a mixture of malto-dextrins and maltose. The amount of such products in a mixture cannot be determined by any simple direct method but, as a rule, it can be arrived at from the specific gravity, copper reducing power and optical activity of the filtered aqueous extract of the food after allowance has been made for the other soluble bodies (*e.g.*, cane sugar, lactose, proteins, &c.) which had been directly determined.

Matters soluble in Cold Water.—Ten grms. of the sample were extracted for three hours in 200 cc. distilled water at 15·5° C. with frequent stirring. When the fat present exceeds 5 per cent. it is advisable to extract the defatted material. The specific gravity, specific rotatory power and soluble carbohydrates were estimated in the filtrate, and, when the foods contained starch conversion products the soluble proteins were also determined to supply data for the calculation of the quantity of such products. In the absence of the diastase of a malted cereal the additional amount of matter (starch) soluble in water at 35° C. affords confirmatory evidence of the extent to which the starch has been rendered soluble by heating.

Reducing Sugar as Dextrose other than Lactose.—The percentage of this was obtained by direct titration with Fehling's solution of the cold water extract using the method of Ling and Rendle (Analyst, 1905, 30, 182). In most of the foods, more particularly in those the basis of which is flour, a mixture of dextrose and levulose is present, but since the reducing powers of these two sugars is very similar and the total quantity present is usually under 2 per cent. the result may well be returned as dextrose.

In all cases where lactose is present the reducing action of this sugar has to be corrected for when calculating "Dextrose."

Cane Sugar.—Another portion of the cold water extract was boiled with a 2 per cent. solution of citric acid to invert the cane sugar, and the solution after neutralisation was then titrated with Fehling's solution. From the value for invert sugar so obtained is deducted the dextrose already found, and, the difference reduced by 5 per cent. (hydration correction) is the percentage of cane sugar. When the cane sugar exceeded 2 per cent. another portion of the solution was inverted with yeast for four hours at 55° C., the cane sugar being determined from the change in specific rotation using the Clerget formula.

Lactose.—The direct estimation of lactose by chemical methods in presence of certain sugars presents considerable difficulties on account of the small differences which exist between the measurable functions of these carbohydrates. The formation of insoluble mucic acid when lactose is oxidised with nitric acid has been used as a means of estimation (Tollens, Annalen, 1885, *227*, 223), but the results cannot be regarded as satisfactory, and with small amounts of lactose such as are likely to occur in foods the errors are so great as to render the method useless. (*cf.* Report of the Connecticut Agric. Expt. Stat. Food Products, 1908, p. 601). It became necessary to devise an analytical process which could be used to estimate small quantities of lactose.

In a paper by the writer and H. F. E. Hulton (Analyst, 1910, *35*, 512) it was shown that an aqueous solution of lactose, unlike maltose, dextrose, cane sugar, &c. is not fermented by ordinary

brewer's yeast and that small amounts of lactose added to such materials as flour or mixtures of flour and fermentable sugar can be estimated fairly accurately by measuring the reducing action of the residue after fermentation on Fehling's solution. The following is the procedure which was adopted:—

The aqueous extract of the material was boiled with 2 per cent. citric acid to invert any cane sugar (and so facilitate its fermentation) it was then exactly neutralised, the solution cooled and a little cold water extract of a diastatic malt added. For approximately 2 or 3 per cent. of mixed sugars 0·5 grm. per 100 cc. of freshly washed brewer's yeast was added, and, if the material is non-nitrogenous, a little yeast water was run in. The flash was closed with a plug of cotton wool and kept in an incubator for 72 hours at a temperature of 27° C. Under these conditions any fermentable sugar will be completely fermented. The solution which now contains no reducing sugar except lactose was cleared with a little alumina; filtered, boiled and made up to an appropriate volume and titrated with Fehling's solution. Ten cc. of Fehling's solution correspond to 0·074 grms. pure lactose. In the many control estimations which have been made by this method the results are usually about 5 per cent. too low.

The estimation of lactose by this method in presence of hydrolysed starch products such as occur in certain of the foods, presents greater difficulties since malto-dextrins even when fermented in presence of diastase leave a small residuum which reduces Fehling's solution. As the writer is unaware of any other procedure for the estimation of lactose in such complex mixtures of sugars as are present in these infants' foods it became necessary to determine the error which would be introduced if this residuum were calculated as lactose. In a number of fermentations of different kinds of hydrolysed starch products this unfermentable residue, had it been calculated as lactose, would have amounted to from 3 to 4 per cent. of the total weight of the material fermented. As no food consists entirely of these products the error will consequently always be less than the amount just mentioned. In the case of foods 54, 68 and 73 a proportional deduction was made to correct the lactose value.

Fat.—The only form in which fat, other than that natural to cereals, has been found in these foods is that introduced by the admixture of dried milk preparations, and a word of warning is necessary as to its estimation when so present. The trace of fat derived from the cereals may be extracted with ether in a Soxhlet apparatus using 10 grms, or more of the material. But, as pointed out in the Connecticut Agricultural Report (*loc. cit.*, p. 604) mere ether extraction is often insufficient to deal with the fat as found in some foods, and this the writer has found is more particularly the case with some of the modern preparations of dry milk. Owing to the inclusion of fat globules the solvent action of the ether may be almost entirely inhibited. This was notably the case with Food No. 68 which yielded only 1 per cent. of fat after 24 hours of ether extraction in a Soxhlet appartus, but gave 8·5 per cent. by the Werner-Schmidt and Röse-Gottlieb methods. Even the convenient and accurate Röse-Gottlieb method fails with

these refractory dried milks unless special precautions are taken—such as preliminary warming of the material with the ammonia before the addition of the alcohol, petroleum and sulphuric ethers, &c. (McLellan, Analyst, 1908, 33, 353, Richmond, ibid, 1908, 33, 389.) In any case where doubt existed the Werner-Schmidt method was used as a confirmatory test.

Proteins.—The nitrogen was determined on 0·5 grm. of the food by the Kjeldahl-Gunning method, and the figure multiplied by the factor 6·25. This factor was adopted as it is the conventional one, but it is too high for gliadin and glutenin, the only proteins present in the majority of the foods, for since these substances contain 17·5 per cent. nitrogen the correct factor would be 5·7. The resulting protein value may be therefore 10 per cent. high which is a total error of about 1 per cent. in most of the foods analysed. To have gone fully into the question of the correct factor for each food would have necessitated the identification of the proteins present, and this in the case of the malt extract preparations would have been a laborious and unnecessary proceeding, taking into consideration how little is known as to the nutritive values of malt proteins and their cleavage products.

Moisture.—Five grms. were dried in a water oven at 98° C. for five hours.

Mineral Matter.—Five grms. were burnt at a low red heat in a muffle. Some of the foods burnt with difficulty, in such cases sulphuric acid was previously added and the usual correction of one-tenth of the weight of the ash deducted.

Cellulose.—By this term is meant for the purposes of this report carbohydrate matter not starch, insoluble in boiling water and not attacked by diastase. None of the foods examined contained a measurable quantity of crude fibre, that is to say material remaining unaltered when boiled with 1·5 per cent. of sulphuric acid followed by 1·5 per cent. caustic soda, but all of them contained substances, probably hemicelluloses and pentosans, which resisted boiling and subsequent prolonged treatment with diastase. As it was considered important to obtain a measure of any material present in the foods which would resist natural digestion the method about to be described was adopted. Possibly results more nearly approaching what occurs during digestion of the fodd by the infant might have been obtained by subjecting the food (made up according to directions) to the progressive action of salivary diastase (ptyalin), pepsin in 0·5 per cent. hydrochloric acid solution, and pancreatic extract (trypsin, pancreatic amylase, &c.), but this lengthy procedure is hardly necessary considering the small quantity of "cellulose" present in the foods.

Five grms. of the material (extracted with ether when more than 1 per cent. of fat was present) were stirred into a thin paste with cold water and about 200 cc. of distilled water added after which it was brought to the boil and the boiling continued for about half-an-hour. The solution was then cooled to 80° C. and 5 cc. of the malt extract (prepared by extracting a diastatic malt with three times its weight of cold water for an hour and then filtering bright) were added and at the expiration of five minutes again brought to the boil, then cooled to 60° C. and a further

25 cc. of the cold malt extract added. The digestion was maintained at this temperature for 3 to 4 hours and the contents of the beaker then passed through a dried tared filter paper. The residue was repeatedly washed with water at 60° C., and when quite free from all reducing sugar with alcohol and ether, dried for several hours in the boiling water oven and weighed in a stoppered bottle. Filter paper and residue are then transferred to a Kjeldahl flask and the protein determined in the usual manner. This procedure is carried out in duplicate, the ash being determined on the second residue, instead of the nitrogen. The first weight less the protein and ash is the figure returned as " cellulose." Most of the coagulated protein left on the filter is derived from the malt extract used to effect the conversion of the starch.

Saccharifying Diastase.—This was determined by the Lintner Method as modified by the Institute of Brewing (J. Inst. Brewing, 1906, *12*, 6).

Three cc., or more in the case of material low in diastatic activity, of a 5 per cent. cold water extract of the material were allowed to act for one hour at 21° C. on 100 cc. of a 2 per cent. solution of soluble starch. At the end of the hour further action was arrested by the addition of 10 cc. of N/10 soda solution and the whole made up to 200 cc. The amount of maltose present was determined by titration with Fehling solution and thus a measure was obtained of the activity of the starch-saccharifying enzyme. By definition a material is said to have a diastatic activity of 100 when 0·1 cc. of the 5 per cent. solution produces under the above conditions enough maltose (viz., ·04 grm.) to reduce completely 5 cc. of Fehling solution. If 0·2 cc. is required the diastatic power is 50°; if 0·3 it is 33·3° and so forth.

Liquefying Diastase.—With regard to the nature of the diastase present in these preparations it should be borne in mind that the Lintner method of measuring diastase records only the saccharifying power. Material which has been malted possesses in addition the property of liquefying starch paste. Liquefying diastase is far more resistant to the action of wet or dry heat than saccharifying diastase; in fact it is possible for some of the foods, *e.g.*, Nos. 20, 26, 44 and 73 to show only slight evidence of saccharifying diastase whilst liquefying diastase is present.

Since no reliable method of quantitatively measuring this property is available the results are recorded in qualitative terms. For the test, the change in viscosity in ten minues at 20° C. produced by the action of 10 cc. of a 5 per cent. cold aqueous extract of the food was noted.

Alkalinity.—Fifteen grms. of the sample were digested for an hour with 60 cc. of distilled water; 20 cc. of the filtrate (=5 grms. of material) were diluted and titrated against N/50 H_2SO_4 using methyl orange as indicator. Ordinary flour so treated shows an alkalinity of about 0·15 per cent. calculated as $NaHCO_3$ due probably to dipotassium phosphate in the soluble ash. In the analyses of the foods the expression " faintly alkaline to methyl orange " indicates that not more than this degree of alkalinity was present. When the material showed any alkalinity to litmus or

more than 0·15 per cent. of sodium bi-carbonate to methyl orange, the evolution of CO_2 on treatment with acid was measured in order to obtain confirmation of the presence of alkaline carbonates or bi-carbonates.

Examination of some Proprietary Infants' Foods.

In the majority of cases the temperature at which the food is directed to be prepared is such that the starch is gelatinised and therefore even if the food be "malted" the diastase has no opportunity of converting the starch paste. As further evidence that this is so, these foods were made up according to directions, suitably diluted, and titrated with Fehling's solution. Had the saccharifying diastase not been destroyed there would be an increase of reducing power as compared with that of the cold aqueous extract of the food. In no case was any such increase noted. In those foods where it is possible for the diastase to exert its functions the amount of starch remaining unaltered can be arrived at as follows:—

The food is made up according to prescribed conditions (using water instead of milk) diluted to a suitable volume, filtered, and the specific gravity determined. From this is deducted the specific gravity of the cold aqueous extract of the food and the difference can be approximately calculated into the starch which has been changed into soluble products.

Before proceeding to the detailed analysis of the different foods it may be of interest to cite analyses of the three principal ingredients which, either alone or blended, enter into the composition of most of these foods, viz., wheaten flour, dried milk and dried malt extract. The last mentioned was made by mashing a barley malt with flour at a temperature of 60° C., filtering, boiling and evaporating the liquid to dryness. This product was entirely soluble in water.

——	Flour.	Dried Milk.	Malt Extract.
	Per cent.	Per cent.	Per cent.
Starch	70·4	Nil	Nil
Hydrolysed starch products	Nil	Nil	90·0
Reducing sugars as dextrose (other than lactose).	1·8	Nil	—
Lactose	Nil	39·0	Nil
Cane sugar	1·3	Nil	2·5
Fat	1·1	28·7	Trace
Proteins (N. × 6·25)	11·0	23·8	4·1
Water	13·1	1·4	1·5
Mineral matter	·4	5·8	1·5
Cellulose	1·5	Nil	Nil
	100·6	98·7	99·6
Reaction to methyl orange	Sl. alk.	Alk.	—
Saccharifying diastatic power ...	15·5°	Nil	Nil
Liquefying do. ...	Nil	Nil	Nil

The description of the food and the directions for use printed in small type at the head of each of the analyses are taken from statements contained on the label or in printed matter attached to the package of the particular sample.

No. 1.

"———" Food for Infants and Invalids; already cooked. A pure blood, bone, muscle and flesh former. Price 6*d*. Pure, easily digested, very nourishing.

For Infants. Under three months, one-third of milk is sufficient; over this age a little more milk may be used; mix one teaspoonful of the food with milk to the thickness of cream, add sugar to taste, pour on half a pint of boiling milk and water, equal parts, stirring well while pouring on, then boil one minute, keeping well stirred.

Analysis.

	Per cent.
Starch	66·0
Reducing sugars as dextrose (other than lactose)	0·3
Cane sugar	9·5
Fat	1·0
Proteins	8·8
Water	10·1
Mineral matter	0·6
Cellulose	1·4
	97·7

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	17°
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	2·7 per cent.

There is no evidence that the starch in this preparation has been rendered more than slightly soluble by the heating to which it has been subjected and by which the gluten forming capacity has been destroyed. Its analysis is consistent with a mixture of wheaten flour and cane sugar. As prepared for use all the starch is present in a gelatinised condition.

No. 2.

"———" Food. No. 1 for Infants.

Directions for Use for Infants up to eight months of age.

During first week's use (at any age). Fill feeding bottle half with water and half with fresh cow's milk; pour the mixture into a saucepan, sprinkle in half table-spoonful of the food, warm gently to a feeding temperature and stir until the food is dissolved.

After first week. Prepare as above, using one table-spoonful of the food instead of half table-spoonful.

Analysis.	Per cent.
Starch	Trace.
Hydrolysed starch products	79·7
Cane sugar	2·2
Fat	0·1
Proteins	6·3
Water	4·9
Mineral matter	1·7
Cellulose	3·0
	97·9

Reaction ... ... Alkaline to methyl orange. No carbonate or bi-carbonate present. The alkalinity is due to the phosphates in the hydrolysed starch products.

Saccharifying diastase, Lintner ... 5·0°

Liquefying diastase ... ... Present.

The starch used in the preparation of this food is completely transformed by the action of diastase of a malted cereal into a mixture of maltose and malto-dextrins. As both saccharifying and liquefying diastase are present the food during the process of manufacture was evaporated at a low temperature under diminished pressure, or, since a trace of starch is in the food the presence of these enzymes may be due to the addition of a very small quantity of malt flour. The food when prepared according to directions contains active diastase.

No. 3.

"———" Food. A cooked food strengthened with extracted wheat phosphates and albuminoids, and therefore the most nutritious food in the world for infants: develops bone, muscle, teeth and brain, and enriches the blood.

Directions.

For quite young babies put a teaspoonful of the food (one-third ounce) into a breakfast cup; pour on QUICKLY sufficient cold water to make a thin smooth paste, stirring briskly all the time. Gradually fill up with boiling milk and water (one-third milk and two-thirds water). Boil slowly for six minutes or longer.

The food may be given in an ordinary feeding bottle.

Analysis.	Per cent.
Starch	52·6
Reducing sugars as dextrose (other than lactose)	3·6
Cane sugar	12·5
Fat	0·8
Proteins	14·4
Water	5·6
Mineral matter	1·7
Cellulose	4·0
	95·2

Reaction	Faintly acid to litmus. No soluble carbonates present.
Saccharifying diastase, Lintner ...	Nil.
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	2·3 per cent.

The microscopic appearance of the food is suggestive of its having been heated as the granules are somewhat distorted. The heating, however, has not been carried very far otherwise there would be a greater difference than 2·3 per cent. between the amounts soluble in water at 15° C. and 35° C. Cane sugar has been added and there is a higher percentage of protein in the sample than in ordinary wheat flour.

No. 4.

FARINACEOUS FOOD for Infants and persons with impaired digestion.

Directions enclosed.

N.B.—No directions are enclosed. On the lid of the tin are the words,

"——— ——— Farinaceous Food for Infants and Invalids."

Analysis.

	Per cent.
Starch	74·6
Reducing sugars as dextrose (other than lactose)	1·6
Cane sugar	1·2
Fat	1·0
Proteins	10·0
Water	9·6
Mineral matter	0·5
Cellulose	1·0
	99·5

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	Nil.
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	24·3 per cent.

This food may be regarded as a wheaten flour considerably altered by heating. The extent of alteration is indicated by the considerable amount of matter soluble in water at 35° C. As might be expected the diastase has been destroyed and although there are no directions given for the preparation of the food it

will, if made with water or milk, contain two-thirds of the starch. The remaining one-third will form a true solution in water and will not be in the gelatinised state.

No. 7.

"————'s" Food. Most nutritious food for Infants and Invalids.

Directions.

Infants' Food. Put half oz. (dessert-spoonful) of ————'s Food into a basin, mix gradually with cold water into a stiff paste, then add two tea-cupfuls of cold water, mix well, pour into a clean saucepan, stir briskly until it boils, and allow it to boil slowly for five minutes (stirring occasionally), add a little salt or sugar. One or more table-spoonfuls may be given according to age with each bottle of milk.

Analysis.

	Per cent.
Starch	62·2
Reducing sugars as dextrose (other than lactose)	0·4
Cane sugar	0·9
Fat	8·2
Proteins	11·4
Water	7·0
Mineral matter	1·5
Cellulose	6·7
	98·3

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase	Nil.
Liquefying diastase	Nil.
Nature of starch	Oat.
Difference between matter soluble in water at 15° and 35° C. ...	2·0 per cent.

This food has a composition similar to that of a fine oatmeal. As would be expected the percentage of fat and cellulose is high. When prepared according to directions all the starch was gelatinised but not otherwise changed.

No. 9.

"————'s" Natural Food for Babies and Invalids.

Directions to prepare the Food.

For Babies. Put one teaspoonful of the food into a breakfast cup; mix this perfectly smooth with two parts milk to one of water, until the cup is full. Pour into a saucepan and bring to the boil, stirring all the time to prevent it getting lumpy. It is best without sugar, and should be given cool.

Analysis.

	Per cent.
Starch	68·2
Reducing sugars as dextrose (other than lactose)	1·1
Cane sugar	1·7
Fat	2·2
Proteins	9·6
Water	8·7
Mineral matter	1·1
Cellulose	5·2
	97·8

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	8°
Liquefying diastase	Nil.
Nature of starch	Wheat with probably some oat.
Difference between matter soluble in water at 15° and 35° C. ...	2·3 per cent.

The analysis of this preparation is consistent with its being a mixture of heated wheat flour and oatmeal in which the former considerably predominates. When prepared the food is practically a gelatinised paste, the saccharifying diastase being unable to effect any conversion.

No. 13.

"The Food that digests itself."

. . . . . food is the easiest to digest and the most nutritious food known.

"———" is purified, condensed, unsweetened . . . . . meal or flour, absolutely nothing added, nothing taken away. It is not a cereal. . . . . .

Directions for serving.

Infants under 3 months.

(No. 1) Sift a teaspoonful of "———" into half pint boiling water; add half pint cows' milk; salt liberally; sweeten slightly. Put into bottle.

(No. 2) Teaspoonful of "———"; pint boiling water; 3 tablespoonfuls evaporated cream; salt liberally.

Infants 3 to 6 months.

One and one-half table-spoonfuls "———"; three-quarters pint milk; one-half pint boiling water; salt liberally.

Analysis.

	Per cent.
Starch	75·2
Reducing sugars as dextrose (other than lactose)	0·7
Cane sugar	1·6
Fat	0·1
Proteins	1·8
Water	12·4
Mineral matter	1·9
Cellulose	4·3
	98·0

Reaction	Slightly alkaline due to presence of phosphates.
Saccharifying diastase	Nil.
Liquefying diastase	Nil.
Nature of starch	Probably *Colocasia*.
Difference between matter soluble in water at 15° and 35° C. ...	3·6 per cent.

The fanciful claims for this food are quite unjustified having regard to the small quantities of fat and proteins present. It is possibly prepared from the starch contained in the rhizomes of *colocasia*. The difference between matter soluble in water at 15° and 35° C. suggests that the material has been heated, probably to destroy any enzyme capable of splitting a cyanogenetic glucoside which may be present. When prepared according to the directions the food consists of a mixture of milk and gelatinised starch.

No. 14.

"———" Food; a substitute for Cod Liver Oil. The only cheap and agreeable Farina, possessing true hygienic properties for the use of invalids and an Invaluable Diet for Infants.

Directions for Use.

Food for Invalids. To a table-spoonful of "———" Food made into a paste, add a pint of boiling milk and let it boil four minutes, stirring it all the time.

For an Infant. Add boiling water to a little of the above mixture and sweeten.

Analysis.

	Per cent.
Starch	72·2
Reducing sugars as dextrose (other than lactose)	Trace.
Cane sugar	1·3
Fat	1·0
Proteins	8·1
Water	13·1
Mineral matter	0·6
Cellulose	1·9
	98·2

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	21°.
Liquefying diastase	Present.
Nature of starch	Probably a mixture of arrowroot and a cereal.
Difference between matter soluble at 15° C. and 35° C.	3·6 per cent.

The analysis suggests that the food consists of arrowroot to which has been added a small quantity of malt flour. Such a mixture would show a higher percentage of matter soluble at

35° C. than at 15° C. as during extraction some of the starch would be attacked by the diastase. When prepared for use the diastatic activity is quite destroyed and the food is simply a mixture of gelatinised starch and milk. The small percentage of fat does not support the claim of the manufacturer that this food may serve as a substitute for cod liver oil.

No. 16.

"———" Malted Milk Food for Infants and Invalids. Containing the properties of pure malt, and the saccharine element of milk, with carefully cooked wheat flour. A most nutritious and easily digested food, admirably adapted for young and delicate infants, forming THE BEST SUBSTITUTE FOR MOTHER'S MILK.

Directions for Use.

For Infants. Mix a large teaspoonful with a little cold water or milk into a thin paste, then pour upon it half a pint of boiling milk or water, and stir briskly. It can then be sweetened and is ready for use.

Analysis.

	Per cent.
Starch	60·2
Reducing sugars as dextrose (other than lactose)	1·4
Lactose	1·8
Cane sugar	9·9
Fat	1·6
Proteins	10·7
Water	8·1
Mineral matter	1·3
Cellulose	2·3
	97·3

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	14°.
Liquefying diastase	Present.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	2·1 per cent.

The analysis of the food is indicative of its being a mixture of wheaten flour and a malted cereal with a small quantity of lactose. When made up for use the temperature is such that the diastase present is destroyed and the starch is consequently only gelatinised.

No. 17.

"———'s" Digestive Food for Infants and Invalids. A pure nutritious health-giving and strengthening food.

For Infants. Put one dessert-spoonful of the food into a basin, mix to the thickness of a smooth cream with cold milk or water, then put into a saucepan, add about half a pint of milk and water in equal parts, and stir until brought to the boil. When somewhat cooled, put into the feeding bottle, draw through the teat and feed the child. Sweeten to taste when boiled. As the child grows, the quantity of food should be increased, and milk used instead of water.

Analysis.

	Per cent.
Starch	71·5
Reducing sugars as dextrose (other than lactose)	0·3
Cane sugar	1·1
Fat	1·3
Proteins	10·2
Water	10·6
Mineral matter	0·6
Cellulose	1·7
	97·3

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	1°.
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	1 per cent.

This analysis closely resembles that of a flour which has been heated sufficiently to destroy most of the diastase. The starch present in the food prepared for use will be in the gelatinised state.

No. 20.

The most perfect substitute for Mother's Milk—" ———'s " Malted Food for Infants and Invalids.

Directions for Infants.

Take one teaspoonful to a table-spoonful of the Food, make it into a smooth paste with water, and pour upon it (stirring continuously) half a pint of boiling milk and water, in proportions suited to the age of the child. Allow the food to come to the boil. A little sugar may be added if desired.

Analysis.

	Per cent.
Starch	69·8
Reducing sugars as dextrose (other than lactose)	1·3
Cane sugar	4·9
Fat	1·5
Proteins	11·4
Water	6·1
Mineral matter	0·7
Cellulose	3·0
	98·7

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	1°.
Liquefying diastase	Present.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	1·7 per cent.

The diastatic activity of this food is very slight. A very small quantity of malt flour may possibly have been added to wheaten flour previously heated. A small quantity of cane sugar has also been incorporated. The mode of preparation of the food for use does not afford any scope for action of the diastase with the consequence that the starch will be present in a gelatinised state.

No. 21.

FINEST HYGIENIC MALTED FOOD. Most nutritious digestible and wholesome for Infants and Invalids.

Directions for Use.

Mix a table-spoonful of the Food with cold milk or water to form a paste, then make up to half a pint with boiling milk or milk and water, pour into a saucepan and boil gently for two minutes, stirring it all the time, sweeten to taste.

For Infants the food should never be made with more than equal quantities of milk and water.

Analysis.

	Per cent.
Starch	65·3
Reducing sugars as dextrose (other than lactose)	3·3
Lactose	4·2
Cane sugar	1·0
Fat	1·6
Proteins	12·3
Water	5·8
Mineral matter	1·1
Cellulose	2·4
	97·0

Reaction	Faintly alkaline to litmus.
Saccharifying diastase, Lintner ...	7°
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	Nil.

The fact that there is no liquefying diastase present may be regarded as evidence that this food contains only the diastase natural to a flour which has been slightly heated. The amount of reducing sugars other than lactose which are present is probably accounted for by the addition of a small quantity of evaporated malt extract (inactive so far as diastase is concerned). Lactose has been added.

Gelatinised starch is present in the food as prepared for use.

No. 26.

"———'s" FOOD for Infants and Invalids. Malted and cooked. The best food for Infants and Invalids. A perfect substitute for Mother's milk. Prepared expressly for Infants. Possessing every requirement necessary for children brought up wholly or partially by hand.

Directions for Infants. Take one teaspoonful to a table-spoonful of the Food, make it into a smooth paste with water, and pour upon it (stirring continuously) half a pint of hot milk and water in proportions suited to the age of the child, and boil for about one minute. A little sugar may be added if desired.

Analysis.

	Per cent.
Starch	69·5
Reducing sugars as dextrose (other than lactose)	1·2
Cane sugar	4·3
Fat	1·6
Proteins	11·6
Water	6·6
Mineral matter	0·6
Cellulose	3·2
	98·6

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	Trace.
Liquefying diastase	Present.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	2·4 per cent.

This analysis is consistent with a mixture of wheaten flour a small quantity of cane sugar and malt flour. The mixture was heated as the saccharifying diastase is practically destroyed. The starch is present in a gelatinised condition in the food as prepared for use.

No. 28.

"———" *Farinaceous Food.*

For Infants, Invalids and the aged.

Description. A genuine malted food as originally recommended by Baron Liebig for Infants and young children.

Directions for Infants. Take from one to four teaspoonsful of "———" Food according to age, with one dessert-spoonful of best Demerara sugar and mix well in a basin with a little cold water; then pour upon it half-a-pint of boiling milk and water and boil from 3 to 5 minutes. When lukewarm (100° F.) it is ready for use.

Analysis.

	Per cent.
Starch	73·9
Reducing sugars as dextrose (other than lactose	Trace.
Cane sugar	1·4
Fat	1·1
Proteins	9·2
Water	10·0
Mineral matter	1·4
Cellulose	2·9
	99·9

Reaction	Alkalinity to methyl orange and litmus due to presence of soluble carbonates. If calculated as sodium bicarbonate about 1 per cent. is present.
Saccharifying diastase, Lintner ...	6·0°
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	Nil.

These analytical data suggest that the food is a wheaten flour heated sufficiently to prevent the formation of gluten. The diastase present is characteristic of an ungerminated cereal. The food has an alkaline reaction and when prepared for use the starch is in the gelatinised condition.

No. 29.

The "———" Food.

For Infants and Invalids.

A self-digesting farinaceous diet.

Directions for use.

To make stock—mix half-a-pint of cold milk with half-a-pint of cold water. Set on half of this to boil, *well stir* two dessert-spoonsful of "———" Food into the remaining cold milk and water. Now turn the boiling into the cold (not the cold into the boiling), and having well stirred return to the fire and boil for five minutes until the food thickens. This amount will last a day.

For Infants. To feed the Infant—about every two or three hours. Two parts of stock (*see* above). Two parts of cold milk. Two parts of boiling water.

Analysis.

	Per cent.
Starch	68·9
Reducing sugars as dextrose (other than lactose)	1·1
Cane sugar	1·6
Fat	1·5
Proteins	12·7
Water	10·4
Mineral matter	0·5
Cellulose	3·0
	99·7

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	13·0°
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	Nil.

The analysis of this food indicates that it is a wheaten flour heated sufficiently to inhibit the formation of gluten. When prepared for food the starch present will be in a gelatinised state.

No. 31.

"——" *Original Malted Oatmeal.*

Description.—Contains malt, 1 grain of which digests 2,000 grains of starchy foods, such as bread, potatoes, oatmeal, &c.

Directions for Infants. Mix a large teaspoonful of "——" Malted Oatmeal with a little cold water, to the thickness of cream, add half-a-pint of hot water and milk, boil for two minutes, stirring constantly, sweeten to taste; it is then ready for use.

Analysis.

	Per cent.
Starch	63·6
Reducing sugars as dextrose (other than lactose)	0·6
Cane sugar	0·6
Fat	7·8
Proteins	11·4
Water	10·3
Mineral matter	1·0
Cellulose	3·0
	98·3

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	Nil.
Liquefying diastase	Nil.
Nature of starch	Oat.
Difference between matter soluble in water at 15° and 35° C. ...	Nil.

This food is an oatmeal and the entire absence of soluble diastase negatives the claim that it is malted. As prepared for use the starch will be present in a gelatinised condition.

No. 32.

For Infants and Invalids. Malt and Prepared Food.

Prepared for . . . . . .

Directions. For Infants take two or three heaped-up teaspoonfuls according to age, and mix into a thin paste with a table-spoonful or more of milk. Add half a pint of water and boil for a few minutes.

Analyst's report states . . . . . I infer that the Food is made from the constituents of Fresh Cows' Milk and cooked corn, and I also find malt present.

Analysis.

	Per cent.
Starch	65·6
Reducing sugars as dextrose (other than lactose)	2·6
Cane sugar	10·7
Fat	1·0
Proteins	9·8
Water	6·0
Mineral matter	0·7
Cellulose	2·1
	98·5

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	7·0°
Liquefying diastase	Present.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	4·1 per cent.

The analysis of this food is suggestive of a mixture of heated wheaten flour sweetened with about 10 per cent. of cane sugar and a small quantity of malt flour. The difference between matter soluble in water at 15° C. and 35° C. is due for the most part to diastatic action during extraction. The directions for the preparation of the food are vague and any conversion of the starch into maltose and malto-dextrins will depend on the time taken to raise the mixture to boiling.

No. 33.

"——" *Malted Food.*

For Infants and Invalids. Greatly Superior to a healthy Mother's Milk.

Directions for Infants. Mix a dessert-spoonful into a thin paste with a little milk, pour on gradually half a pint of milk and water (equal parts of each) boiling hot, and stir all the time.

Analysis.

	Per cent.
Starch	73·6
Reducing sugars as dextrose (other than lactose)	0·8
Cane sugar	1·5
Fat	1·3
Proteins	11·0
Water	7·9
Mineral matter	0·8
Cellulose	2·4
	99·3

Reaction	Alkaline to methyl orange and litmus. Due to presence of soluble carbonates. If calculated as sodium bicarbonate about 1·0 per cent. is present.
Saccharifying diastase, Lintner ...	7·0°
Liquefying diastase	Present (slight).
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	1·6 per cent.

Probably a very small quantity of malt flour has been used in the manufacture of this food and to this limited extent its description is justified. The basis of it is a heated flour. As prepared for use the diastase of the food is destroyed and the starch remains in a gelatinised state.

No. 36.

"———" Special Food for Babies.

A perfect substitute for Mother's milk.

Directions for Use. For Infants. Take two or three heaped-up teaspoonsful according to age, and mix into a thin paste with a table-spoonful or more of milk. Add half a pint of water and boil for a few minutes.

Analysis.

	Per cent.
Starch	20·0
Hydrolysed starch products...	45·3
Cane sugar	9·2
Fat	0·5
Proteins	8·8
Water	7·2
Mineral matter	1·9
Cellulose	3·1
	96·0

Reaction	Alkaline to methyl orange but not to litmus. Alkalinity due to phosphates in hydrolysed starch products.
Saccharifying diastase, Lintner ...	2°
Liquefying diastase	Present.
Nature of starch	Wheat (much distorted).

The analytical results indicate that this food has been prepared by allowing a malted cereal to act on flour. The starch

remaining is some which was either unattacked during manufacture or was added subsequently. Since both forms of diastase are present the food was evaporated at a low temperature, or malt flour was incorporated. Cane sugar was added. The food prepared according to directions contains the starch in a gelatinised state.

No. 44.

"———" *Cooked Malt Food.*

For Infants and persons of delicate digestion.

Description.

Most of the so-called infants' foods are mere mixtures of starchy meals, and quite unfit for the delicate digestion of infants. This cooked malt food is a carefully prepared combination of Malted Nutritious Cereals, thoroughly and carefully cooked to render it suitable for the weak digestions of Infants and Invalids.

Directions for Use.

For Infants.—To one table-spoonful of the food, add sufficient water to make a thin paste, pour this into half-a-pint of hot milk and water in a saucepan, bring it quickly to a boil (constantly stirring), the food is then ready for use; a little sugar may be added. The proportions of milk and water vary with the age of the infant; up to six months one-third milk is sufficient; from that age to twelve months equal proportions of milk and water may be taken.

Analysis.

	Per cent.
Starch	62·6
Reducing sugars as dextrose (other than lactose)	1·5
Cane sugar	9·8
Fat	1·5
Proteins	9·8
Water	9·8
Mineral matter	0·6
Cellulose	3·0
	98·6

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	Present in very small quantity (under 1°).
Liquefying diastase	Present.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	3·4 per cent.

The analysis of this food is consistent with its being a mixture of heated flour, 9 per cent. of cane sugar, and a little malt flour. Owing to the presence of a small amount of malt diastase the difference between the amount of matter soluble in water at 15° and 35° C. is somewhat high. The directions for preparing the food for consumption are vague, but if the term "hot" means a temperature of about 50°-60° C. the starch will be gelatinised but not otherwise altered.

No. 51.

The " ——— " Cooked Wheaten Food for Infants and Invalids.

Directions.

Place from a dessert to a table-spoonful of the " ——— " Wheaten Food in a basin, and reduce to a cream with cold milk or water; then add about half a pint of boiling milk or water and sweeten to taste. The thickness and strength of the food can be regulated according to the age of the child. For infants the best way of giving the Food is by means of the Feeding Bottle. For Mothers nursing, this food is especially suitable.

Analysis.

Starch	71·1
Reducing sugars as dextrose (other than lactose)	0·6
Cane sugar	1·7
Fat	2·0
Proteins	13·0
Water	6·2
Mineral matter	0·7
Cellulose	3·6
	98·9

Reaction	Neutral.
Saccharifying diastase, Lintner ...	Nil.
Liquefying diastase	Nil.
Nature of starch	Wheat and oat.
Difference between matter soluble in water at 15° and 35° C. ...	2·2 per cent.

This analysis, especially the rather high values for cellulose and fat, is suggestive of a mixture of heated wheat flour and oatmeal. When prepared for use the starch will be in the gelatinised state.

No. 54.

(" ———'s " *Infant Food*).

Description. Contains the same nourishing substances as mother's milk and in the same proportions. The food tables and directions for use are inside each wrapper.

Directions for use.

For single meals.

——	Infants under			
	1 month.	2 months.	3–4 months.	5–6 months.
Food (teaspoonsful) ...	¼–⅓	½–¾	¾–1	1–1½
Milk (large tablespoonsful)	2	3–4	5–6	7–8
Water (large tablespoonsful)	3–4	4–5	5–4	4

Dissolve " ——— " in the water. Boil mixture, stirring carefully, add the milk and bring the whole to the boiling point.

Analysis.

	Per cent.
Starch	16·6
Hydrolysed starch products	21·4
Lactose	7·0
Cane sugar	16·0
Fat	6·5
Protein	15·3
Water	5·9
Mineral matter	4·0
Cellulose	4·6
	97·3

Reaction	Faintly acid to litmus.
Saccharifying diastase, Lintner ...	Nil.
Liquefying diastase	Nil.
Nature of starch	Probably much altered wheat.

These analytical figures suggests that the food is a mixture of hydrolysed starch products, dried milk and cane sugar. The starch is much distorted and probably has escaped complete conversion by diastase in the process of manufacture. It will be present in the gelatinised state in the food when prepared for use according to the directions given. The phosphoric acid soluble in cold water is equivalent to 0·8 per cent. of di-potassium hydrogen phosphate (K_2HPO_4).

No. 56.

" ——————'s " best Food for Infants and Invalids.

Perfect for Infants.

Directions for Use for Infants.

Put the food into a basin or other convenient vessel and make it into a thin smooth paste with about one-fifth (in the summer one-fourth) of the *cold* milk and water. Then heat the remainder of the milk and water to *boiling*, and pour it with constant stirring on the thin paste. The mixture will thicken and then rapidly become fluid. The food is ready for use when sufficiently cooled.

Or, make a thin paste as above directed, add the remainder of the cold milk and water, and then heat the whole in a saucepan until the mixture thickens when, without further heating, it must be immediately removed from the fire, allowed to become fluid again and then to cool down. The thickening takes place at a temperature of 140°–145° F.

The proportions of food and of milk and water generally found most suitable are as follows:—

Age 1–3 months, a very small teaspoonful of the food, gradually increased to a full teaspoonful at 3 months, with 3, 4 or 5 table-spoonfuls of the mixture of one part of milk and two parts of water. (Other proportions are given for infants between 4 months and 10 months.)

Analysis.

	Per cent.
Starch	71·4
Reducing sugars as dextrose (other than lactose)	3·3
Cane sugar	2·1
Fat	1·5
Proteins	12·6
Water	7·6
Mineral matter	0·8
Cellulose	1·6
	100·9

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	5°.
Liquefying diastase	Strong.
Nature of starch	Wheat
Difference between matter soluble in water at 15° and 35° C. ...	13 per cent.

This analysis is consistent with the food being a mixture of wheaten flour and a malted cereal. The presence of the latter is shown by the saccharifying and liquefying diastase. As prepared for use at least 70 per cent. of the starch present is converted into maltose and malto-dextrins.

No. 58.

"———'s" *Food.*

For invalids and infants (here follow extravagant claims for curing various kinds of diseases). The best food for infants and invalids generally, as it is the only food which never turns acid on the weakest stomach.

On the accompanying circular of directions the following statement occurs:—

"Infants fed with the '———' made thin in water and salt to pass through the feeding bottle thrive better upon it than on nurses' milk."

Directions for Use.

The careful preparation of our food is most essential to insure the greatest possible benefit to sufferers.

The first consideration is the mixing of the food with cold water. This should be done very gradually, and carefully, so as to produce a perfectly smooth and even paste, before adding the remaining liquid (water or milk). Fifteen to twenty minutes boiling (continually stirring with a wooden spoon) over a slow fire, will then suffice to produce a most appetising and nutritious meal. If cooked in water a little salt should be added; if in milk, a little moist sugar. From 1½ to 2 table-spoonsful of food to a pint of liquid will be sufficient.

In another paragraph it says that: "As a highly nourishing tonic for convalescents or for ladies nursing or for infants, it may be prepared as thick as cream (at first thin like milk for infants being reared with it)."

Analysis.

	Per cent.
Starch	53·4
Reducing sugars as dextrose (other than lactose)	0·7
Cane sugar	4·2
Fat	1·2
Proteins	24·2
Water	10·3
Mineral matter	2·1
Cellulose	3·4
	99·5

Reaction	Slightly acid to litmus.
Saccharifying diastase, Lintner ...	6·0°
Liquefying diastase	Slight.
Nature of starch	Bean (lentil).
Difference between matter soluble in water at 15° and 35° C. ...	2·2 per cent.

This food consists of lentil flour without any addition of other materials. When prepared for use practically all the starch will be in a gelatinised condition.

No. 60.

"... ...'s" Patent (Cooked) Food.

For Infants and Invalids.

Notice.—This food can be used With or Without Milk.

Directions.

For infants, invalids and the aged.

Mix a teaspoonful of the patent food with a little cold water or milk to the thickness of cream, then add to it ½ pint of hot water or milk, stirring it; directly it boils it is ready for use; sweeten to taste.

N.B.—For infants up to 4 months old the mixture should be sweetened with the sugar of milk purchased from the chemist, as ordinary sugar will frequently disagree with the baby.

Analysis.

	Per cent.
Starch	73·3
Reducing sugars as dextrose (other than lactose)	0·5
Cane sugar	1·7
Fat	1·3
Proteins	8·9
Water	10·7
Mineral matter	0·7
Cellulose	1·8
	98·9

Reaction	Faintly alkaline to methyl orange.
Saccharifying diastase, Lintner ...	Less than 1°.
Liquefying diastase	Nil.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° and 35° C. ...	Nil.

This food is a wheaten flour heated sufficiently to destroy its diastase. As prepared for use all the starch will be present in a gelatinised condition.

No. 63.

"———'s" *Banana Malted Food.*

Description.

Containing selected cooked cereals, choice banana meal, extract of malt, specially prepared wheat phosphates, and the solid constituents of pure cow's milk containing 93 per cent. of proteid.

Directions.

For children of 12 months and upwards mix a dessert-spoonful of the Food with cold water into a thin paste, add gradually (while stirring) half a pint of hot milk, then repour into the saucepan and just boil up gently, well stirring the while. Sweeten to taste.

For Young Infants the food should be mixed very thin in the same way, and just boiled up in fresh milk and water of about equal parts.

Analysis.

	Per cent.
Starch	64·9
Reducing sugars as dextrose (other than lactose)	5·0
Lactose	Nil.
Cane sugar	4·7
Fat	2·0
Proteins	10·7
Water	8·6
Mineral matter	1·5
Cellulose	2·4
	99·8

Reaction	Alkaline to methyl orange. If calculated as sodium bicarbonate 0·45 per cent. is present.
Saccharifying diastase, Lintner ...	2°
Liquefying diastase	Strong.
Nature of starch	Wheat and banana.
Difference between matter soluble in water at 15° and 35° C. ...	3·5 per cent.

This analysis supports to a certain extent the claims of the manufacturer that the food is a mixture of heated cereal flour, banana meal and malt extract. The small percentage of mineral

matter negatives the statement that any material quantity of phosphates has been added. As no lactose was found the "solid constituents of pure cow's milk" are certainly not present, although a protein such as casein may have been added. The directions for preparing the food are vague but it is probable that a small quantity of the starch present undergoes conversion.

No. 68.

"———'s" *Malted Milk.*

Description.

Suitable for infants from birth. In powder form, free from starch. No cooking or milk required. Malted milk is a reliable food for infants. It is complete in itself, perfectly soluble, palatable, readily assimilated, free from disease germs, starch, or preservatives, and very easily prepared.

It is composed of an extract of selected wheat flour and barley malt and pure, pasteurised cow's milk, reduced to dryness at low temperature in vacuo. The starch of the grains is converted into soluble dextrin and maltose . . . . . .

This product contains nutritive elements in the proper proportions to support life and health.

Directions for infants.

First month.—One half to 1 teaspoonful in 1 to 2 ozs. of water, every 2 hours with 10 meals.

Second and third months.—1 to 3 heaping teaspoonfuls, in 3 to 4½ ozs. of water, every 2 to 3 hrs., 10 to 8 meals. (Further directions for later months.)

Analysis.

	Per cent.
Starch	Nil.
Hydrolysed starch products	53·4
Lactose	10·0
Cane sugar	3·7
Fat	8·5
Proteins	14·0
Water	3·2
Mineral matter	4·1
Cellulose	Nil.
	96·9

Reaction	Alkaline to methyl orange and litmus. Alkalinity due to soluble carbonates. If calculated as sodium bicarbonate 1 per cent. is present.
Saccharifying diastase, Lintner ...	Not present.
Liquefying diastase	Not present.

In general terms the analytical results are consistent with those of a mixture of one third full fatted dried milk and two thirds of hydrolysed starch products.

No. 73.

"_____'s" Milk Food for Infants.

Description.

Specially manufactured for the rearing of infants from birth. Being scientifically prepared and easy of assimilation, this food is practically identical with, and contains all the life building constituents of, mother's milk.

"_____'s" Milk Food for Infants requires no addition but water, as it contains everything that is necessary for bringing up the infant from birth until it is about 6 months of age, when a stronger diet may be given.

Directions.

Mix one heaped-up dessert-spoonful of the food with two of hot water, and stir into a smooth paste, then add a sufficient quantity of boiling water to make a quarter of a pint altogether, constantly stirring whilst adding the boiling water.

The above directions are for a child of 8 weeks old or under; as the child grows older the quantity of food may be gradually increased.

Analysis.

	Per cent.
Starch	11·7
Hydrolysed starch products	10·0
Lactose	20·0
Cane sugar	11·7
Fat	16·6
Proteins	15·0
Water	5·2
Mineral matter	3·8
Cellulose	2·5
	96·5

Reaction	Alkaline to methyl orange. The alkalinity is due to phosphates; carbonates are not present.
Saccharifying diastase, Lintner ...	Under 1°.
Liquefying diastase	Strong.
Nature of starch	Wheat.
Difference between matter soluble in water at 15° C. and 35° C. ...	3·4 per cent.

The analytical results suggest that this food is a mixture of hydrolysed starch products, dried milk, cane sugar and malt flour. The starch present is probably derived from the malt and most of it would be unchanged further than gelatinisation if the directions for the preparation of the food are followed.

No. 83.

"_____'s" Food.

For Infants, Invalids and the aged.

When mixed with warm milk, or milk and water, according to the directions on the tin, the natural digestive principles it contains become active, the casein of the milk is so modified thereby, that firm indigestible curds cannot be formed in the stomach, whilst the basis of the food itself is rendered soluble.

Directions.

For half a pint of prepared food take 1 table-spoonful (about ¾ of an ounce) of ———'s Food, 4 table-spoonsful of *cold* milk, mix to a smooth paste in a basin, and then add gradually whilst stirring ½ a pint (a breakfastcupful) of boiling milk and water. Set aside, away from the fire, for a quarter of an hour, when the digestive process will have sufficiently advanced, then pour into a saucepan and slowly heat, whilst stirring, till it boils; when sufficiently cool it is ready for use. A table-spoonful of cream may be added with advantage.

N.B.—For very young infants use *level* table-spoonfuls (½ oz. each) or less if ordered, of the food and milk and water in the proportion of one third milk and two thirds water, gradually increasing the proportion of milk.

Analysis.

	Per cent.
Starch	73·7
Reducing sugars as dextrose (other than lactose)	1·2
Lactose	Nil.
Cane sugar	1·2
Fat	0·9
Protein	11·6
Water	8·5
Mineral matter	1·1
Cellulose	0·9
	99·1

Reaction	Alkaline to methyl orange, due in part to the presence of carbonates. If calculated as sodium bi-carbonate 0·75 per cent. is present.
Saccharifying diastase, Lintner ...	18°.
Liquefying diastase	Strong.
Nature of starch	Wheat.

The analysis of this food is suggestive of a wheaten flour to which has been added an active preparation of an amylolytic enzyme; as the food is alkaline this has probably been introduced as pancreatic extract. When prepared according to the directions quoted about 70 per cent. of the starch present undergoes conversion into soluble products.

A summary of the foregoing analyses is appended to this report (*see* p. 82-3).

From a consideration of these analytical results it will be seen that the foods may be conveniently divided into the following five classes:—

(1) Foods consisting of dried cows' milk mixed with hydrolysed starch products or malt flour. Samples 54 and 73 both

contain less than 20 per cent. of starch and none of it is altered during preparation for use. Sample 68 contained no starch.

(2) Foods consisting for the most part of ground meals such as wheaten flour, lentil, oatmeal, or arrowroot, and in which no alteration of the starch, other than that caused by heating, has taken place during manufacture. With the exception of sample 4, the heating has not greatly affected the solubility of the starch. Incidentally, however, the capacity for forming gluten has been destroyed. In these preparations only gelatinisation and not conversion of the starch occurs when the food is made up for use according to directions. Samples 1, 3, 4, 7, 9, 13, 17, 28, 29, 31, 51, 58, and 60 are examples. Of these, samples 4, 7, 9, 13, 17, 28, 29, 31, 51, 58, and 60 consist solely of the ground cereal. Samples 1 and 3 have had cane sugar added.

(3) Foods consisting of ground meals as in class 2, but mixed with a proportion of malt flour or malt extract. These foods when prepared for use contain the starch in a gelatinised condition. Samples 14, 16, 20, 21, 26, 32, 33, and 44 are examples. Sample 16 contains lactose and cane sugar, 21 lactose, and 20, 26, 32, and 44 a little cane sugar.

(4) Foods in which the starch is altered during process of preparation according to directions. In samples 56 and 83, three-quarters of the starch originally present is converted into soluble substances. A little change may take place in samples 32 and 63.

(5) Partially or wholly altered starch foods. In these foods the starch or some of it has been converted into soluble products during the process of manufacture. Sample 36 is a partially converted preparation, whilst sample 2 is entirely converted.

The majority of the foods belong to Classes II. and III. and of these samples 16, 26, 31, 33 and 44 and sample 32 of Class IV. are labelled in a misleading manner, as the purchasers might reasonably expect to find that in a food which claims to be "malted" the starch has either already been modified or will undergo some conversion whilst the food is being prepared for use.

It will be further noticed that the foods, with a few exceptions, contain only two per cent. of fat or less. Such foods when prepared according to the directions given will contain only a little more fat than that which is present in the added mixture of milk and water. Some of the foods claim to be the most perfect substitute for mother's milk but children fed on them would have a diet dangerously low in fat. Food No. 36 which contains 0·5 per cent. of fat and is directed to be made up practically with water only is a particularly bad instance in this respect. Mention may also be made of Food No. 33 containing only 1·3 per cent. of fat, which claims to be "greatly superior to a healthy mother's milk," and food No. 14 (1 per cent. of fat) stated to be a substitute for cod liver oil. In some instances attempts have been made so to adjust the composition of the food that when prepared for use, it shall approximate in some degree to the fat content of human milk. Samples 7, 31, 54, 68 and 73 are

examples. Attention has already been directed to the manner in which the globules of fat in some of the milk foods are protected from the solvent action of ether. This is a point of some significance, as it is possible that a portion of the fat in such foods escapes absorption in the infant's system.

In most of the samples the percentage of protein is equal to that of an average wheaten flour. Foods 2 and 13 are exceptions. Many difficulties present themselves in discussing a low content of protein as there are no data to show to what extent the proteins of cereals are assimilated by the infant.

The difference between the ratio of casein to lactalbumin in human and cow's milk is well known, the more important aspects of this matter as regards the preventive action of the lactalbumin on the casein clot having been discussed by J. Alexander and J. G. M. Bullowa (J. Amer. Med. Assoc. 1910, 55, 1196).

Whatever the value of the mechanical part played by these foods in preventing such clotting their use involves the taking of a considerable quantity of gelatinised starch. Enzymes capable of hydrolysing starch occur in the saliva, and in the pancreatic secretion (of infants). In addition to these an amylase has been found in the juice secreted by the small intestine (Hamburger and Hekma, J. de Physio. et de Path. generale, 1902 and 1904). The chemical properties of the cleavage products of starch by salivary and pancreatic diastase have not been investigated to any great extent. It is generally held that the behaviour of pancreatic and salivary amylase is very similar to that of the diastase of a germinated grain, the starch being first liquefied and then changed to maltose and a series of malto-dextrins of decreasing molecular complexity. Should the saliva or pancreatic juice of an infant contain little starch liquefying enzymes there may be formed dextrins, such as α amylodextrin, resistant to further diastatic action, and closely approaching starch in molecular weight (J. L. Baker, *J. Chem. Soc.*, 1902, 77, 1177).

The capacity of the infant for dealing with gelatinised starch is referred to at length by Dr. Coutts in Section IV. of his report, which also deals with the general question as to the advisability of the use of starch in infants diet and the extent to which starch may be digested by infants.

JULIAN L. BAKER.

A. W. J. MacFadden,
Chief Inspector of Foods,
Local Government Board,
March, 1914.

Summary of Analyses of Proprietary Foods dealt with in the Report.

	1.	2.	3.	4.	7.	9.	13.	14.	16.	17.	20.	21.	26.	28.	29.
Starch, per cent. ...	66·0	Trace	52·6	74·6	62·2	68·2	75·2	72·2	60·2	71·5	69·8	65·3	69·5	73·9	68·9
Hydrolysed starch products, per cent.	Nil	79·7	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Reducing sugar as dextrose (other than lactose) per cent.	0·3	—	3·6	1·6	0·4	1·1	0·7	Trace	1·4	0·3	1·3	3·3	1·2	Trace	1·1
Lactose, per cent. ...	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1·8	Nil	Nil	4·2	Nil	Nil	Nil
Cane sugar, per cent. ...	9·5	2·2	12·5	1·2	0·9	1·7	1·6	1·3	9·9	1·1	4·9	1·0	4·3	1·4	1·6
Fat, per cent.	1·0	0·1	0·8	1·0	8·2	2·2	0·1	1·0	1·6	1·3	1·5	1·6	1·6	1·1	1·5
Proteins, per cent. Nitrogen × 6·25.	8·8	6·3	14·4	10·0	11·4	9·6	1·8	8·1	10·7	10·2	11·4	12·3	11·6	9·2	12·7
Water, per cent. ...	10·1	4·9	5·6	9·6	7·0	8·7	12·4	13·1	8·1	10·6	6·1	5·8	6·6	10·0	10·4
Mineral matter, per cent.	0·6	1·7	1·7	0·5	1·5	1·1	1·9	0·6	1·3	0·6	0·7	1·1	0·6	1·4	0·5
Cellulose, per cent. ...	1·4	3·0	4·0	1·0	6·7	5·2	4·3	1·9	2·3	1·7	3·0	2·4	3·2	2·9	3·0
Saccharifying diastase, degrees Lintner.	17·0	5·0	Nil	Nil	Nil	8·0	Nil	21·0	14·0	1·0	1·0	7·0	Trace	6·0	13·0
Liquefying diastase ...	Nil	+	Nil	Nil	Nil	Nil	Nil	+	+	Nil	+	Nil	+	Nil	Nil
Nature of starch ...	Wheat	Nil	Wheat	Wheat	Oat	Wheat and oat.	Colocasia.	Arrowroot and a cereal.	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
Difference per cent. between matter soluble in water at 15° and 35° C.	2·7	—	2·3	24·3	2·0	2·3	3·6	3·6	2·1	1·0	1·7	Nil	2·4	Nil	Nil

Summary of Analyses of Proprietary Foods dealt with in the Report—*continued.*

—	31.	32.	33.	36.	44.	51.	54.	56.	58.	60.	63.	68.	73.	83.
Starch, per cent. ...	63·6	65·6	73·6	20·0	62·6	71·1	16·6	71·4	53·4	73·3	64·9	Nil	11·7	73·7
Hydrolysed starch products, per cent.	Nil	Nil	Nil	45·3	Nil	Nil	21 4	Nil	Nil	Nil	Nil	53·4	10·0	Nil
Reducing sugar as dextrose (other than lactose) per cent.	0·6	2·6	0·8	—	1·5	0·6	—	3·3	0·7	0·5	5·0	—	—	1·2
Lactose, per cent. ...	Nil	Nil	Nil	Nil	Nil	Nil	7·0	Nil	Nil	Nil	Nil	10·0	20·0	Nil
Cane sugar, per cent. ...	0·6	10·7	1·5	9·2	9·8	1·7	16·0	2·1	4·2	1·7	4·7	3·7	11·7	1·2
Fat, per cent.	7·8	1·0	1·3	0·5	1·5	2·0	6·5	1·5	1·2	1·3	2·0	8·5	16·6	0·9
Proteins, per cent. Nitrogen × 6·25.	11·4	9·8	11·0	8·8	9·8	13·0	15·3	12·6	24·2	8·9	10·7	14·0	15·0	11·6
Water, per cent. ...	10·3	6·0	7·9	7·2	9·8	6·2	5·9	7·6	10·3	10·7	8·6	3·2	5·2	8·5
Mineral matter, per cent.	1·0	0·7	0·8	1·9	0·6	0·7	4·0	0·8	2·1	0·7	1·5	4·1	3·8	1·1
Cellulose, per cent. ...	3·0	2·1	2·4	3·1	3·0	3·6	4·6	1·6	3·4	1·8	2·4	Nil	2·5	0·9
Saccharifying diastase. degrees Lintner.	Nil	7·0	7·0	2·0	Under 1	Nil	Nil	5·0	6·0	Under 1	2·0	Nil	Under 1	18·0
Liquefying diastase ...	Nil	+	+ Sl.	+	+	Nil	Nil	Strong	+ Sl.	Nil	Strong	Nil	Strong	Strong
Nature of starch ...	Oat	Wheat	Wheat	Wheat much distorted.	Wheat	Wheat and oat.	Probably wheat much altered.	Wheat	Bean (lentil).	Wheat	Wheat and banana.	—	Wheat	Wheat
Difference per cent. between matter soluble in water at 15° and 35° C.	Nil	4·1	1·6	—	3·4	2·2	—	13·0	2·2	Nil	3·5	—	3·4	—